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Death of Sir George H. Knibbs.

Since the last issue of this *Journal* appeared, the death has occurred of Sir George H. Knibbs, K.B., C.M.G., &c. He passed away at his home in Melbourne on the 30th March last after a long illness. Poignant regret and wide-spread sympathy with his family were evoked by the announcement of his death in the daily papers, and many sincere tributes were paid to his rare personal qualities, his remarkable intellectual and scientific interests, and the eminent services he rendered during his long and distinguished career as a public servant. A man of many gifts, Sir George Knibbs, by sheer force of merit and achievement, won his way to the highest positions in the Service of the Commonwealth Government. But he was more than a distinguished public official. He was a scientist of distinction, a scholar of attainment, an accomplished linguist, a man of wide culture, and a writer of scholarly verse. By the public, he will always be widely remembered as the first Commonwealth Statistician, and the founder of the successful Commonwealth Bureau of Census and Statistics. But those who knew him more intimately are aware that he would surely have risen to eminence in any of the branches of cultural or scientific work with which he was associated.

The son of the late Mr. John Handley Knibbs, of Sydney, George Handley Knibbs was born on 13th June, 1858, and was educated in Sydney. His first experience as a public servant was gained in the General Survey Department of New South Wales. His special qualifications were recognized early, and in 1889 he was appointed to the teaching staff of the Department of Engineering at the University of Sydney. His distinguished service as a lecturer resulted later in his appointment as Acting Professor of Physics. While engaged in his University work, he became honorary secretary to the Royal Society of New South Wales, a post which he held for nine years. The gratitude of the members for his loyalty and enthusiasm found expression in his election as President for the year 1898-99. He was destined to become president of many other bodies in his lifetime. Included in the list is the presidency of the Institution of Surveyors—an office that he held for four years (1892-93, 1900-1); of the New South Wales section of the British Astronomical Association (1897-98); of the Sydney University Engineering Society (1897-98); and of the Society for Child Study (1903, 1904, 1905). Among his numerous appointments was that of a Royal Commissioner on various investigating bodies. As Australia's representative, he attended the International Congress on Life Insurance, held in Vienna; the meeting of the Special Committee for the Revision of Nomenclature of Diseases, which met in Paris; and an International Congress, held in Copenhagen, on the Scientific Testing of Materials.

He was the Commonwealth's delegate to the International Institute of Statistics in Paris, and the Geodetical Congress in London. These five European congresses were held in 1909. In 1920, he attended the British Empire Conference of Statisticians in London, which drew up a plan for uniform statistics throughout the Empire.

In 1905, the Commonwealth Census and Statistics Act was passed, and the Bureau of Census and Statistics was created in the following year. It was the good fortune of the Commonwealth to secure in Sir George Knibbs a man who had a genius for the collection and compilation of national statistics. With untiring industry, he organized this most valuable department of public records, and the *Commonwealth Year-Book,* first published early in 1908, is to-day a monument to his energy, clear-sightedness, and enthusiasm.

The achievement of a long and meritorious career came in 1921, when Sir George Knibbs was appointed Director of the Institute of Science and Industry, which had been created by an Act passed in the previous year, and it is in his work in that capacity that readers of this *Journal* will perhaps be most interested. The first steps for the establishment of a Commonwealth organization to undertake the work of scientific industrial research had been taken in 1916, when the Prime Minister (the Rt. Hon. W. M. Hughes, P.C., LL.D., M.P.) convened a conference to consider the matter. As a result, a temporary Advisory Council of Science and Industry was appointed, and held its first meeting in April, 1916. This body was constituted under the chairmanship of Sir David Masson, for the purpose of paving the way for a permanent organization, which it was then anticipated would be created at an early date. By the middle of 1917, the temporary body had completed the preparatory work for which it was specifically appointed, but as the necessary action for the establishment of the permanent organization was not taken until 1920, the temporary body remained in existence until that time. In the meantime, the late Dr. F. M. Gellatly had been appointed, in 1918, as Chairman of Directors of the then proposed permanent Institute. Dr. Gellatly died in September, 1919.

In his first Annual Report, published in 1922, Sir George Knibbs showed that he possessed a remarkable perception of what would be necessary to fulfil Australia's requirements in respect to scientific industrial research for the development of her industries, both primary and secondary. In that report, he included a diagrammatic scheme which showed how the functions of the Institute should be developed, and which may appropriately be taken to serve as the ultimate goal to be reached in the comprehensive organization of a national scientific industrial research institution. Unfortunately, owing to financial limitations, he was never able to give effect to the scheme of development which he had formulated. He recognized clearly that the full development of his scheme would cost a large sum of money, and that it could be effected only in the course of many years. He strongly urged, however, that a beginning should at once be made, and that initially efforts should be concentrated on certain more important branches of investigation, which he specified, and which were very similar to the lines of work which are now being developed by the Council for Scientific and Industrial Research. The very valuable work initiated by the temporary Advisory Council was continued and developed by Sir George Knibbs, but, with one or two exceptions, no funds were available to enable him to embark on the many new important activities which he so strongly

advocated. Nevertheless, in spite of the difficulties under which he laboured, it was largely due to him that many important inquiries were co-ordinated and a harmonious conjunction of interests established, and that the foundation was laid for many new investigations which are now being pursued by the present Council.

When the existing Council for Scientific and Industrial Research was created in 1926, after Sir George Knibbs's retirement, it was immediately able to avail itself of the exceedingly valuable plans which he had prepared for the development of the work. It was, moreover, able to bring about the development of certain investigations which had been initiated either by him or by the former temporary Council. In this way, not only has the present Council been able to dispense with an enormous amount of preparatory and initiatory work which would otherwise have been inevitable, but it has also been able either to bring to conclusion or to hasten on various investigations which had already been commenced, and in this way to secure substantial advantages by the accumulation of results of considerable economic importance. The debt which the present Council owes to Sir George Knibbs's foresight, energy, and scientific attainments cannot be over-estimated.

A tribute to Sir George Knibbs's services to science was paid by Sir John Monash in 1923, on the occasion of the latter's installation as President of the Australasian Association for the Advancement of Science, at the meeting held in Adelaide, when Sir George Knibbs retired from the presidential chair. In the course of his presidential address, Sir John Monash remarked:—

> "Sir George Knibbs is one of a small band of men who have rendered great and continuous services to this Association. He has been a member of it from its birth, 36 years ago. He has been its Vice-President for fourteen successive years, and he has, during the term of his occupancy, adorned and rendered notable the presidential office. Sir George stood in the esteem of the world of science and learning in an unchallengeable position. His profound erudition, his graceful culture, his eloquent discourse, and his wide and reliable scientific labours make up that charming personality which has commanded the admiration, the respect, and the affection of his generation. It would be difficult to recite in adequate terms the tale of his service to the nation and to science, of the innumerable scientific bodies which claim the privilege of his membership, and of the products of his fertile and fruitful pen."

Sir George Knibbs's charm of manner, and his unvarying kindness of heart, made him hosts of friends all over the world. Unlike many whose lives are associated with the study of advanced mathematics, he remained intensely human in his interests and in his outlook on life, and his death is mourned by a wide circle of friends. The Executive Committee of the Council for Scientific and Industrial Research has expressed its appreciation of the late Sir George Knibbs in the following terms:—

> "That the Council for Scientific and Industrial Research desires to record its very high appreciation of the distinguished services rendered to science by the late Sir George Knibbs, and its sense of the severe loss the Commonwealth has sustained by his death. The Council feels deeply that it will always owe a debt to him for the valuable work he carried out as Director of the former Institute of Science and Industry."

Forest Products Research.

By I. H. Boas, M.Sc., Chief of the Division of Forest Products Research.

Mr. Boas commenced duty as Chief of the Council's Division of Forest Products Research in July, 1928. Shortly after, he left Australia on a visit to Europe and America to make himself familiar with recent developments, and with the methods adopted at forest products research organizations in those countries, and also to discuss possible lines of co-operation. He returned to Australia in January, 1929, and wrote the following article partly in the light of the information he obtained abroad.—Ed.

1. General.
2. The Madison Forest Products Laboratory.
3. The Forest Products Laboratory at Princes Risborough.
4. Conditions *re* Research in Australia.

1. General.

It is a curious fact that outside the British Empire, with the single exception of the United States of America, there is no organized research into forest products. In most forest countries there have been isolated investigations into problems of local interest, such as into the turpentine industry in France; but no attempts at a co-ordinated scheme covering this fertile field. There is a proposal at present to begin a forest products laboratory in Germany, at Eberswalde, but so far nothing has been done.

Organized research into forest products began in the United States about twenty years ago, and has been continuously developed there since. It began at various scattered forest schools; but finally was centred in the one institution at Madison, Wisconsin. The success which followed the establishment of this laboratory, and particularly its enormous extension after America had entered the Great War, has led to similar developments in Canada, India, South Africa, Malay States, and England, and most recently to definite proposals to begin work in New Zealand and Australia. In France and Germany, where scientific forestry has been practised so successfully for so long a time, it is noteworthy that the need for forest products laboratories has not been felt. The reason, however, is clear. In these countries, the virgin forests have long disappeared and have been replaced by plantations, which are of pure stands and managed on sound forestry principles. In addition, they are in closely-settled countries where the standard of living is relatively low. In such circumstances, when a forest is exploited, there are economical uses for all the extracted material. Even the twigs from the fallen trees are collected, tied into bundles, and sold as fuel. Consequently, there is no waste associated with forestry operations, and the same is true in the conversion of the timber into articles of use. It is the enormous waste, so characteristic of the exploitation of the virgin forests in most countries, that has forced attention to the need for more conservative methods. While the forest resources appeared to be inexhaustible, waste flourished. This happy state is rapidly passing, and the world's timber assets have been so seriously diminished that foresters all the world over have been seriously concerned as to the possibility of maintaining supplies for the future. In the forest, only that portion of the tree below where branches begin is extracted. The tops and branches remain to rot and are a source of further loss as they form a good breeding-ground for insect and fungoid pests, and assist in the spreading of forest fires.

In the mill, wasteful conversion is the rule. It is difficult or impossible at present to find economic use for the major portion of the log. Anything from 50 to 70 per cent. of the timber may be wasted at this stage. The mills are far from the centres of utilization, and the cost of transport is often greater than the value of the off-cuts as fuel or for conversion into articles of use. The practice which has grown up in parts of Australia of cutting logs for definite orders is a factor which operates to increase this waste. This practice is one that has nothing to recommend it from a conservative point of view, and it should be discouraged or prevented as far as possible.

In the factory conversion there is further waste, though here the loss is less, as some use as fuel or for conversion to small articles can be found.

In countries like Australia, thinly populated as it is, some waste of timber is unpreventable, but there can be no doubt that much of that which exists at present can and should be prevented. It is only as complete a knowledge as possible of all the properties of our timbers that can form the base of economic utilization. A striking example of waste through ignorance is that of the Huon pine in Tasmania. This valuable timber has been exploited till it is very nearly exhausted. It is remarkably durable, and resists attack of borers, teredo, and fungi. This property was well recognized, and led to the rapid exploitation of the timber. No one, however, was sufficiently anxious to find out why the timber was so resistant to attack until comparatively recently. Chemical investigation yielded an oil which has remarkable powers as a disinfectant, and is a potential source of valuable compounds. The heaps of waste are now being exploited to obtain this oil; but it is sad to think of the huge quantities burned on the fire-shoot before this discovery was made. Many examples of similar waste could be cited. They are not by any means the worst, for much of the waste has not been due so much to ignorance as to carelessness, and a lack of any desire to do more than to exploit the forests for immediate gain, with no care for the future. Such an attitude has led, much sooner than otherwise would have occurred, to the present unsatisfactory forest position.

There is evident, all over the Empire, a realization that wasteful methods must cease, and a recognition of the fact that this can only be brought about by a thorough knowledge of all the properties of the timbers and forest products. Hence the establishment of the various research laboratories, whose aim is the collection of the necessary data and the working out of practical methods for the economic utilization of these properties. The main functions of a forest products laboratory have been very well summarized by C. P. Winslow, Director of the Madison Laboratory, as follows:—

1. A study of the properties of timber.
2. A study of the range of these properties, within each species.
3. The correlation of these variations in properties to such factors as structure, conditions of growth, &c.
4. The modification of the properties by seasoning, preservation, fire-proofing, &c.
5. The study of the effect of such treatments on the properties.
6. Finally, the "why" of the various phenomena.

2. The Madison Forest Products Laboratory.

Madison, Wisconsin, is the birthplace of forest products research, and the huge volume of accumulated data and experience is a big factor in the practical success of the laboratory.

Plans for new buildings were proposed some years ago, but are still unrealized, and the work is consequently scattered over three widely separated buildings, and the laboratories are cramped.

Timber Mechanics Section.

The timber mechanics section is housed in a temporary wooden structure, and is very crowded. The principal new addition to the testing plant is a 1,000,000-lb. machine, at present employed for testing various methods of building construction. Whole walls are built in various ways and tested to destruction. In America, where most of the houses are of timber, better design based on the results of such tests should lead to a very considerable saving. There is also a complete box-making plant, used in manufacturing the boxes for testing out various designs in the box drum. The records of timber tests are very complete. They cover over 1,000,000 tests, from small, clear specimens up to structural sizes and built-up structures. The records occupy a large room, and the system enables the results of any test to be found readily.

The main work in this section consists in the re-working of data collected during the past twenty years, and a great many results of value have been obtained. The patient collection of data over this long period is now bearing fruit. A visit to the section confirms the idea that Australia must soon begin to collect similar data about her timbers. Until this is done, it will not be possible to develop properly those sections whose direct object is to assist the timber-using industries. The basis of all true utilization work is a complete knowledge of the physical properties of the timbers of the country.

Some work on testing under the standard plan is still going on at Madison. It deals mainly with second-growth timbers, and is more or less subsidiary. The main work is a close study of the variations of strength within the various species. The old idea of average strengths is not now regarded as of importance. It is much more valuable to know maximum and minimum values, and the relation of these to specific gravity, rates of growth, and other conditions. Such information is of the greatest importance in the proper grading of timber, and in the selection for specific purposes, and also gives information of considerable sylvicultural value. The importance of this has only been recently realized, and it is only in Madison that sufficient data exist at present to enable this study to be undertaken. It is the most interesting and valuable outcome of the great work on testing small, clear specimens on the standard plan.

The Derived Products (Chemical) Section.

The most interesting new developments are in the section of derived products (chemical). The work of this section illustrates best the great change in the trend of the work, which is so noticeable a feature of the Madison Forest Products Laboratory. In 1919, its work was nearly entirely on the empirical side. Every section was working on trade or forestry problems, and trying to get results that could be used as quickly as possible. At the time, no other method was possible. Now, as the result of the accumulated experience of the past, it is possible

to work at the fundamentals underlying the problems. This is the attitude in almost every section, and really scientific research into the underlying causes of various phenomena is being carried out. This is characteristic of the work done at Madison. The important factor of how moisture moves in wood has been tackled in no less than three of the sections. There was for a while a sharp line of division between the physical and chemical points of view. As the result of several years' team work, the differences are now being resolved, and considerable progress has been made. A publication will shortly be issued setting out the results of the work to date, and it should be of immense value. Curiously, it was the work of the chemical section which threw doubt on the physical results, and really led up to the critical experiments which it is hoped give a good first approximation to the truth in this very important question.

Another very delightful piece of work in this section is that of Dr. Ritter, who has developed a microscopic technique which has enabled him, for the first time, to show the intimate structures of the cell walls of wood fibres. By appropriate methods, Ritter has actually dissected the fibre under the microscope. He has shown that it has an outside wrapper spirally wound like a piece of tape about inner fibrils. These fibrils are also spiral, and it is this structure that gives to the fibre its great mechanical strength. The number of fibrils and the pitch of the spiral vary. The fibrils themselves split up into sub-fibrils, and these again into minute bodies which he has called fusiform bodies. The most recent mail brings news that he has succeeded in making preparations which consist, to the extent of 75 per cent., of these tiny bodies. An X-ray spectrum study of these bodies is the next step projected. This research is of fundamental importance in pulp and paper work.

Other work on the nature and distribution of wood extractives, and on the measurement of the spaces between wood fibres and the rate of movement of moisture through wood, have so far given results of great value.

The relation between moisture content and conductivity, electrical capacity, &c., has been studied, and has led to the development of instruments for the rapid determination of moisture in wood. When these are perfected they will prove of practical value, especially to kiln driers. One form is developed so far that at a particular mill every board passing through the saws is automatically graded for its moisture content as it passes along the saw bench. If above a certain percentage of moisture, the slab is returned to the kilns.

The above lines of work illustrate the change of attitude to forest products research, which is characteristic of the last few years. Examples could be given from almost every section, e.g., much work is being planned to find out the mechanism of shrinkage of timber.

Section of Industrial Investigations.

Another section which has developed largely is that of industrial investigations. This department is the extension agent for the Laboratory. Studies are being made into waste utilization, logging and milling practices, costing of processes, &c.

Lumber standardization forms part of the work of this section. This is carried out in close co-operation with the various associations of lumbermen. Grading rules are being established for all the main commercial timbers, based on the results of the work.

In the introduction of new species to trade, the data from the testing section are used to select species likely to be useful for certain definite uses. Liaison with trade is maintained largely by products officers in each division. The section is devoting its energies to helping the trades by statistical studies in the directions indicated above. At the same time, most of the sections carry on field work.

The Seasoning Section.

In the seasoning section, the old programme of carrying out long series of tests of timbers in the various types of kiln has been abandoned. The work of the section is largely advisory and educational. A field staff is maintained, and regular courses of instruction for kiln operators are held.

The opinion is held that the results of research are so far ahead of practice that it is better at present to concentrate on improving the latter. Nevertheless, the kilns are used from time to time mainly in connexion with work on the fundamental problem of moisture movement.

The Wood Technology Section.

In the section of wood technology, important results have been obtained. The phenomenon of compression wood in conifers has been studied, and has led to an explanation of some of the curious vagaries in the behaviour of timber. A study of brashness, or the tendency to a short break which makes some timber snap like a carrot, is one of the interesting pieces of work.

General.

These examples will serve to show the type of problem being tackled at Madison, and the important results that come from them. Already considerable waste has been saved. There are several paper mills in America which to-day would be closed down were it not for the fact that the Laboratory has shown them how to make paper from hardwood species, hitherto considered of no value. In one timber mill in Vancouver, the huge destructor formerly kept busy burning waste now finds scarcely enough fuel to keep the fire going to burn the sawdust. This is due to the work of the Vancouver Forest Products Laboratory showing how this waste (hemlock) could be economically used in making paper. Incidentally, there seems to be no recognition in America of the fact that the use of hardwoods for paper making was first developed under the old Commonwealth Institute of Science and Industry, and that the paper world first learned of the possibility of this important extension of the industry from Australia.

3. The Forest Products Laboratory at Princes Risborough.

In England, the establishment of a Forest Products Laboratory was only begun three years ago. At first, work was carried on in temporary premises at Farnborough, and in scattered laboratories in London, Oxford, and St. Andrews. About a year ago, a group of laboratories at Princes Risborough was opened, and most of the work is now being carried out at this central station.

The sections so far begun include timber testing; seasoning; preservation; entomology; mycology; technology; physics; chemistry; and utilization. In addition, there are central administration offices, sawmills, workshops, and other general utility departments.

Timber testing on the standard Madison plan (which is now universally adopted by all Forest Products Laboratories) is being carried out on home-grown timbers. The equipment is the very latest in design, and the lay-out of the Laboratory is excellent. In this division, Princes Risborough is the best equipped station in the world. Though the work has so recently begun, it is already proving useful because of the large experience of the officer in charge, who is a Canadian trained in timber testing in the Dominion Forest Products Laboratory.

A batch of five commercial and two small experimental kilns is carrying on valuable seasoning investigations and training kiln operators for the trade.

A finely equipped preservation laboratory, with a 20-ft. cylinder and equipment for open tank work and field tests, is pushing ahead on the many problems of preserving timber against the attack of insects, dry rot, and other fungal diseases. Douglas fir is a difficult timber to impregnate. It has been successfully done in America and Canada, but in England the results were far from satisfactory. This problem is, therefore, being tackled at Princes Risborough, as Douglas fir from Canada is an Empire timber of great importance to England. All the proprietary preservatives on the market are being tested out in field trials.

The technology section includes a big scheme for the microscopic identification of all Empire woods. This extremely important work will naturally take a long time. Many thousands of slides are being prepared and examined. It will be of incalculable value when complete.

In addition, the co-relation of structure to behaviour is studied in order to find the best selection of timbers for specific uses. For example, it has been shown that ash of a certain rate of growth, and in a definite position in the tree, gives the best results in the manufacture of tennis racquets. This work is at present being carried out at Oxford, but is very soon to be transferred to Princes Risborough.

In all these sections, the principle adopted is that at first must come the application to industry of well-established methods. The laboratories are, therefore, mainly engaged getting first hand information on home timbers and endeavouring to get sound practice adopted by the industries. Later on, as at Madison, will come the true research into fundamentals, although this is by no means entirely neglected at present.

Very little chemical work has so far been begun. There are two workers—one in Scotland, and one in Oxford—working at different phases of wood chemistry. So far, there are no chemical laboratories at Princes Risborough, but these are planned for the near future. In physics, one worker is engaged on research into the rate of heat transference in wood, which has a fundamental bearing on the problem of seasoning.

A good entomology section is established. This work was formerly carried out in London, but has recently been moved to Princes Risborough. Experience has shown that it is far better to have all the sections working in close contact with one another, as far as is possible, and the plan is to gather all the scattered work to the one location. Forest products entomology was originally carried on in conjunction with general entomological research in London; but this was found

unsatisfactory. Better progress was made when a separate laboratory was erected for the special inquiries into timber problems. The mycology work is still carried on in London, but will be moved later on.

Finally, the utilization section is centred in Princes Risborough, though its work extends over all England. This section is one of the most important in the organization. Its functions are to study the timber-using industries, and to find out their problems. These are then taken to the Laboratory for solution, and the section again takes to the industries the results of the investigations. The officer in charge is a very experienced man, and is able to advise on the many types of problems in milling, timber conversion, waste utilization, the substitution of other species for those at present considered indispensable for certain purposes, &c. He has behind him the expert assistance of the experienced section heads at Princes Risborough and the full resources of the Laboratory. The value of all this work cannot be over-estimated.

Princes Risborough was selected for the Forest Products Laboratory because—

(1) A suitable site was there, close to a railway siding.

(2) It was near High Wycombe, the centre of the furniture trade in England.

(3) It was near Oxford and the Imperial Forestry Bureau.

(4) It was close to London.

4. Conditions re Research in Australia.

In England, with good roads and short distances, it is not a hard matter for the utilization officer to maintain contact with industries all over the country. It is only a few hours by road to any part of England, and there is a good railway service to London, which takes only an hour. One of the difficulties facing the Forest Products Laboratory in Australia is that of maintaining the contact of the workers with the timber industries, which is so essential to enable a practical bearing to be given to the investigations in hand, and further the difficulty of maintaining close enough contact by means of utilization officers so that the industries may be fully benefited by the work of the Laboratory. Publication of results can never take the place of personal contact. Much could be done if each State Forest Service had attached to it a well-trained utilization officer, who could be in frequent contact with the Laboratory, as well as with the trades in his own State.

The programme of work to be begun in Australia is now under consideration, and it is hoped that very shortly some work will be begun, apart from that of the planning, erection, and equipment of the permanent laboratories.

The Control of Stomach Worms of Sheep in Central Queensland.*

By I. Clunies Ross, D.V.Sc., Veterinary Parasitologist of the Council.

Towards the end of 1928, Professor Brailsford Robertson, Chief of the Division of Animal Nutrition of the Council, was in portions of Central Queensland in connexion with the establishment of one of his divisional field stations in that area. On that occasion the damage being caused to flocks probably by stomach worms was brought to his notice. Subsequently, he discussed the matter with the Executive Committee of the Council, and it was arranged that Dr. Clunies Ross should visit the district and try out the effect of carbon tetrachloride. This was done, and very encouraging results obtained. The following article has accordingly been prepared with a view of guiding pastoralists who may be troubled with a similar problem.—Ed.

1. General.

As a result of the survey carried out by the writer during a visit to portions of Central Queensland, it was found that the worm parasite of greatest importance in the area is the large stomach or wire worm, *Haemonchus contortus,* while of secondary, but in some cases considerable, importance is the nodular worm found in the large intestine. The smaller stomach worms, commonly found in New South Wales and the Southern States, and which may cause serious pathogenic effects, were found to be of very minor importance in this particular district .

2. Life History of the Large Stomach Worm.

In order that the factors on which infestation with this parasite depend may be appreciated, it is necessary that the main outline of the life-cycle of the parasite should be known. The adult worm lives in the fourth stomach of the sheep, and there lays its eggs, which pass out on to the pastures with the droppings. Here they hatch in under 24 hours in spring or summer weather, and the young worms emerge and feed on the manure. After undergoing two changes in structure, the young worm in about five days reaches the stage at which it may infest sheep. At this stage, it is still microscopic in size, and is covered by a double watertight skin so that it can no longer feed, and, therefore, leaves the manure and crawls up the blades of grass, where it will be swallowed by the grazing sheep. It is only by eating grass on which are the young worms that the sheep can become infested, and the pastures can become infested with young worms only through the hatching of eggs which have passed out of the sheep. Apart from the sheep, the worms are quite unable to breed or develop beyond the stage at which they are found on the grass. When the young worms on the grass are eaten by the grazing sheep they pass to the stomach and rapidly grow in size, becoming adult (when they are about an inch in length) in twenty days.

* A full report of investigations on the treatment of stomach worms of sheep, which have been carried out jointly by the New South Wales Department of Agriculture and the Council, will probably be published shortly (either by the Department or the Council).

The adult worms now commence to lay eggs, and these pass out of the sheep in large numbers 30 days after the young worms have been swallowed.

The points to be remembered in connexion with this life-cycle are:—

(1) Pastures become infested with worms only by having wormy sheep or cattle grazing over and contaminating them with droppings.

(2) Once paddocks are contaminated and the young worms are on the grass, they may survive, except in long dry spells, for six months.

(3) Even though sheep are quite free from infestation when put in paddocks where wormy sheep have been run, they will become infested by swallowing the young worms on the grass; and in the same way, even if sheep are freed from all worms by medicinal treatment, they will, if running on "wormy" paddocks, become re-infested.

(4) Warm, moist weather is most favorable to worm life, since the eggs hatch and the young worms develop quickly, while the young worms on the grass are able to survive for long periods in such weather. It is owing to this fact that certain districts, where intermittent rains fall frequently throughout many of the summer months, tend to be affected with worms. It will have been noted that worm troubles frequently become steadily worse until the late summer months.

(5) Cold checks the development of eggs and young worms on the pastures, and frosts may kill both the eggs and the worms. For this reason, fewer young worms are picked up on the grass during the winter months, and as the adult worms in the sheep gradually die, the amount of infestation in a flock grows less throughout the winter.

3. How Stomach Worms cause their Ill-effects.

The particular stomach worm under discussion, besides irritating the stomach wall, actually pierces it and sucks blood. In addition, the worms probably give off poisons which, when absorbed into the blood stream, cause destruction of the solid constituents of the blood, so that it becomes pale and watery. It is owing to this destruction and loss of blood that badly affected sheep show swellings under the jaws, while the membranes of the eye and mouth become very pale and anaemic.

Not all sheep show the same effects from worm infestation, and it is young sheep and lambing ewes which are most susceptible to their effects. The reason for this is that young sheep, like all young animals, are less resistant to all forms of parasitic troubles than adults, partly owing to the strain already thrown on their systems by the demands of their rapidly-growing bodies. Lambing ewes, again, are already placed under the strain of supplying the needs of the growing lambs, either before or after they are born, and consequently they, too, have little margin of resistance to offer to the worms' attack. Aged wethers and dry ewes, owing to the fact that they develop some special resistance to the effects of worms on account of their age, and as they have no other drain on their system, are much more resistant to the effect of the worms, and may show little evidence of the ill-effects of the latter, at the same time that young sheep or lambing ewes on the same pastures

may be seriously affected. In very old age, owing to the resistance of the animals breaking down, they may again become subject to heavy infestation.

4. Treatment and Control of Worm Infestation.

The control of worm infestation may be brought about by:—(i) Attacking the worms in the sheep by medicinal treatment, thus also effecting the temporary cure of sheep badly infested with worms; and (ii) by attacking the worms on the pastures by such measures as burning off, and the use of paddocks in such a way as to reduce the chances of sheep obtaining heavy infections.

The object of the medicinal treatment of sheep is not only to cure them of the effects of worm infestation, but secondly, and more important, perhaps, to kill all the worms in them so that they can no longer produce eggs to contaminate the pastures further. Theoretically, at least, if all the worms in the sheep are killed by repeated drenching, say once a month—that is before the young worms swallowed between drenchings are able to mature and lay eggs—it would be possible to free entirely both pastures and sheep from all stomach worms. The grazing sheep would gradually swallow all young worms on the grass, and these would then be killed in the sheep before they could lay eggs, so that no further contamination of pastures would follow. In practice, however, this is not practicable under Australian conditions (i) because there is no drug known which can be guaranteed to kill every worm, and (ii) because in many instances it is impossible to drench all sheep every three or four weeks throughout the spring, summer, and autumn months. It is possible, however, to reduce losses from worms to a minimum, and to convert what is unsound country because of worms into payable sheep country.

The most effective treatment known at the present time for stomach worm infestation in Australia is the use of carbon tetrachloride, a drug which is also of great value in treating liver fluke infestation. Less effective than carbon tetrachloride is copper sulphate (bluestone), but this drug has the advantage that it is cheaper, easily administered, and very safe.

5. Treatment with Carbon Tetrachloride.

Carbon tetrachloride is given in the following doses:—

Lambs—1 cubic centimetre, or 17 drops.
Adult sheep—2 cubic centimetres, or 34 drops.

Owing to the small size of this dose, the drug must be given in such a way that none of it is lost. It may be administered conveniently (*a*) in gelatine capsules of 1 cc. or 2 cc. size, or (*b*) mixed with four parts of liquid paraffin, making a dose of 5 cc. for lambs, or 10 cc. for adult sheep.*

Before Treatment.—The sheep should be yarded overnight and dosed on the following morning before being allowed food and water. They may be allowed to feed as soon as they have been treated.

Administering Capsules.—The capsules are best given by means of a small balling gun, which can readily be made by taking a piece of stiff rubber tubing of approximately 9 inches in length, and with an internal diameter of ½ inch. A plunger of cane or wood should be

* If desired, the 2 c.c. dose for adults may be mixed with 3 c.c. of liquid paraffin, making a 5 c.c. dose of mixture (for adults).

smoothed down so that it runs easily in the barrel, and should be sufficiently long to form a handle. In order to avoid the danger of injury to the sheep's throat, a guard should be placed on the handle so that when the plunger is driven home the end is not less than $\frac{1}{8}$ inch from the end of tubing. The end of the plunger should be rounded and smooth so that it will not break the capsules. The operator stands in front of the head, the catcher opens the mouth by grasping both upper and lower jaws, and the barrel is inserted and pushed backwards over the base of the tongue, but not hard against the back of the throat. The plunger is then driven home, smartly but not too vigorously, and the gun immediately withdrawn as the holder simultaneously releases the jaws. In this way the sheep swallows the capsule automatically. The administration of capsules by this means is quick and easy; by other methods, such as the use of forceps, it is often uncertain and tedious.

Administering the Liquid.—Where the liquid is used, it should be given by means of a metal syringe holding exactly 5 or 10 cc., according to whether lambs or adults are being dosed, and fitted with a long slightly curved nozzle. The syringe is filled with the liquid, the nozzle inserted over the sheep's tongue, and the syringe emptied steadily. Owing to the fact that carbon tetrachloride evaporates quickly, only a small quantity at a time should be poured from the container into the vessel from which the syringe is filled.

Both these methods of administration have certain advantages. Administration in liquid paraffin is cheaper and more convenient, but on the other hand the drug is sometimes slightly less effective given in this way, and unless care is taken in pouring it out from the large container into one from which the syringe is filled, so much evaporation of the volatile carbon tetrachloride may take place that some sheep may receive practically nothing but liquid paraffin, which would have no effect on the worms. Unless the containers are kept tightly stoppered before and during use, evaporation may also take place. Again, unless metal syringes are used, considerable inconvenience and expense is caused by the syringes breaking. The capsules, though costing more and being less convenient to administer, have the advantage that the dose is accurately measured, and no loss by evaporation should take place, so that every sheep receives the correct dose.

Precautions to be Observed when Dosing with Carbon Tetrachloride.—In certain rare instances, carbon tetrachloride, though absolutely safe for normal sheep in doses five and ten times the size of that recommended, may cause some mortality. The cause of this mortality has never been satisfactorily explained in all cases, but one factor known to influence the toxicity of the drug is the presence of mineral deficiency in the pastures, lack of calcium being of paramount importance in this connexion. Where sheep are known to be, or are suspected of being, on calcium deficient country, they should be given a lick rich in calcium—that is, a lick containing superphosphate, bone meal or calcium phosphate—for one week prior to dosing. This will effectively prevent danger from carbon tetrachloride administration due to calcium deficiency. This precaution is especially necessary when young sheep or lambing ewes running on calcium deficient country are to be treated, since in both of these classes the calcium drain is liable to be most severe.

In addition to the above precautions, it is necessary, where carbon tetrachloride is to be used for the first time, or after a long period has

elapsed since the last treatment, that one week before dosing the whole flock a small percentage of sheep of different classes (young sheep, ewes, wethers), and from different paddocks should be dosed, the carbon tetrachloride used being from the same consignment as that to be used subsequently for dosing the whole flock. If no ill-effects follow this trial drenching it should be perfectly safe to proceed with general drenching.

During the actual administration of the drug, sheep should be held standing, and the head should not be forced too far up or backwards, especially when the liquid is used, and the lower jaw and tongue should be left free. When emptying the syringe into the mouth, the plunger should be pushed home steadily, so that the sheep will have time to swallow and the drug will not enter the windpipe, as this if it occurred might be dangerous.

Finally, it is very necessary to use only chemically pure carbon tetrachloride preparation from reliable firms. The use of impure preparations may be both dangerous and ineffective. Where the above precautions are observed, lambs from three months' old can be given the 1 cc. dose, while ewes in lamb may be treated without other risk than that entailed in yarding and handling them.

6. Treatment with Copper Sulphate or "Bluestone".

Bluestone is administered in the form of a 2 per cent. solution of the drug in water, the solution being prepared as follows:—

Dissolve 8 oz. of bluestone in 3 gallons of water, and of this give the following doses:—

Adult sheep	2 oz.
Two-tooth's	$1\frac{1}{2}$ oz.
Lambs 6 to 12 months	1 oz.
Lambs 3 to 6 months' old	$\frac{1}{2}$ oz.

In preparing the solution, use only hard blue lumps of the drug and discard all lumps that are white and powdery, since these will be inert. Break up the large lumps and dissolve in a little boiling water, then add cold water to make up 3 gallons of solution in an enamel bucket. Do not use an iron bucket or tub for the solution as it will act on the metal, damaging the tub and also becoming less active.

In drenching sheep with bluestone solution, the same precautions should be observed as with the carbon tetrachloride liquid. The sheep should be dosed standing, the head should not be forced upwards and backwards, and the lower jaw should be left free. Sheep should be yarded overnight in the same way and drenched the following morning.

7. General Plan of Treatment and Control.

Usually it is the practice of stock-owners to drench their sheep for stomach worms only when the season is far advanced and the sheep are beginning to show marked effects from worm infestation. Drenching is carried out to cure obviously affected sheep, and if one drenching appears to accomplish this to the extent that deaths are stopped, that frequently is considered sufficient treatment, and no other control measures would be adopted for the year. When necessary to prevent further deaths, additional treatments may be given, but only so long as sheep appear to need treatment urgently. It will have been observed that where such a method of attack on the stomach worm problem is followed, it tends to become worse from year to year until it is questionable whether sheep-raising is any longer profitable.

In this report, it is desired to emphasize the fact that treatment of sheep aims not only at curing affected sheep, and thus enabling them to survive the summer months, but also, and of greater importance, at steadily reducing the extent of infestation from year to year so that worm infestation, if not entirely eradicated, will be reduced to such an extent that it is definitely controllable. For this purpose, it is proposed to outline a scheme of treatment and control extending over one year and designed to reduce infestation of sheep and pastures to a minimum. To effect this it is necessary that not only shall the treatment be faithfully carried out, but that additional control measures, such as the burning off of paddocks wherever possible and the rotation of paddocks, shall be practised. It should further be stressed that the immediate object of such a control scheme is, firstly, to protect young sheep from heavy infestation until they are at least six months old; and, secondly, to endeavour to prevent heavy infestation of lambing ewes.

Owing to the variation in lambing periods on different properties in the district, it is not possible to give definite dates in relation to lambing and weaning, and the scheme must be adapted by individual owners to suit their own conditions.

A plan of treatments that would last over one year is as follows:—

(I.) *All sheep to be treated in July.*—As mentioned earlier, the degree of infestation both in sheep and on the pastures is at its lowest at the end of the winter, owing to the fact that cold is unfavorable to the development of eggs and young worms. If thorough treatment of all sheep is carried out at this time, the great majority of the worms will be killed, so that on the advent of the warmer weather in spring, when development becomes more rapid, few eggs will be passing out on to the pastures.

(II.) *All young sheep and lambing ewes, and if possible all sheep, to be treated in September.*—Treatment at this time will again decrease the output of eggs. By ridding from the bulk of their worms those sheep which later would suffer most severely, it will also mean that such animals will derive the most benefit from the spring, and so be given a much better chance to withstand the later summer infestations. If possible, all sheep on the property should be treated at this time. Where large numbers of sheep have to be dealt with, this treatment may be spread over September and October.

(III.) *Treatment of young sheep and lambing ewes must be repeated at monthly intervals from November to May.*—Young sheep or ewes in lamb, or with lambs at foot, must be repeatedly drenched throughout the worst summer months when the development of worms reaches the maximum. These sheep are the worst harbourers of worms, as well as the worst sufferers, and if the numbers of worms in them are kept down by repeated dosings, the amount of larvae on the pastures should not become dangerous. It must be remembered that, even though all worms in the sheep are killed at each treatment, it would still be possible for sheep in between even regular monthly drenchings to pick up sufficient worms to cause serious ill-effects if subsequent treatments were missed.

(IV.) *All aged sheep other than ewes in lamb should receive at least two drenchings during the worst summer months.*—Though all aged sheep should receive at least two treat-

ments in January and March, it is preferable, where only small numbers of sheep are to be drenched, for all sheep, irrespective of their age, to be given the monthly drenchings from November to April. Where aged sheep only receive occasional drenchings throughout these summer months, care must be taken that paddocks in which they are running are not used by young sheep or lambing ewes without suitable precautions first being taken. This point will be dealt with in the following sections.

8. Other Preventive Measures.

(I.) *Burning-off paddocks.*—Since sheep derive all fresh infestation with stomach worms by swallowing the young worms on the grass, it follows that any measure which will destroy these will most effectively lessen the degree of fresh infestation picked up between treatments. Thorough burning-off of paddocks wherever possible, especially in spring and summer months, is a most valuable aid to control, particularly when employed in conjunction with medicinal treatment. So far as is practicable, it should be the aim to place sheep immediately after treatment—when they are freed from the majority of their worms—on paddocks which have been burnt off and then left unstocked until treated sheep are placed in them.

(II.) *Protection of young sheep.*—Perhaps the most dangerous age for young sheep in relation to worm infestation is when they are just weaned and thrown on their own resources, and it is necessary that at this time they shall be protected from heavy infestation. In the case of weaners, therefore, the animals should be dosed just before being separated from the ewes, and they should then be transferred to clean burnt paddocks. In all cases where aged sheep are not dosed so frequently as young sheep, the latter should never be placed in paddocks previously occupied by the undrenched adults unless the paddocks are first burnt off thoroughly. Such paddocks would be heavily contaminated with eggs and young worms, and young sheep would therefore be likely to be quickly and heavily re-infested.

(III.) *Heavy stocking to be avoided.*—Where stomach worms are a serious problem, over-stocking makes control much more difficult, and should be avoided until such time as the worms are well under control. It is obvious that the more worm-infested sheep graze over a given area, the heavier will be the degree of contamination with eggs and young worms, while the likelihood of sheep grazing over such an area deriving a heavy infestation is increased to an even greater degree. In addition, heavy stocking makes it much more difficult to apply such measures, as the burning off of pastures, and the rotation of stock from infested to clean paddocks. It may be advisable, therefore, to understock deliberately until such a time as worm infestation is easily controllable.

(IV.) *The use of licks.*—It is known that the use of licks for sheep which are grazing on country becoming deficient in such necessary mineral constituents as calcium and phosphorus is of great assistance in enabling such sheep to resist disease in various forms, and against none is it of greater value than worm infestation. In any scheme of worm control, it should be considered absolutely essential, therefore, to ascertain in what particular the pastures lack the necessary constituents,

and to supply these in the form of licks. The type of lick most suitable for any particular class of country should be ascertained from the local Department of Agriculture.

9. Conclusion.

In conclusion, it is wished to urge the necessity for sustained action in any effort to control worm infestation. It is by no means an easy problem, and there is no sovereign remedy which is both very cheap, easy to apply, and thoroughly effective. Stock-owners must realize that the solution of this problem will depend on the thorough application of not only one, but all the measures outlined above, but they may be assured that success will more than repay all the money and energy expended.

Imperial Agricultural Bureaux.

1. Introduction.
2. General Effect of Scheme.
3. The new Bureaux.
4. Their Functions.
5. Official Correspondents.
6. Finance.
7. The Executive Council.

1. Introduction.

One of the most important matters dealt with by the first Imperial Agricultural Research Conference, held in London in 1927, was the question of establishing clearing houses for the interchange of information of value to research workers in agricultural science throughout the Empire. The Conference was impressed by the representations made in favour of Imperial clearing stations of a comprehensive character for the subjects of soil science, animal nutrition, and animal health, and they recommended that clearing stations on the scale of "Bureaux" should be established for these three subjects. The Conference considered the question of establishing, as part of these proposed new Bureaux, additional laboratories for attacking Imperial problems, but came to the conclusion that any such investigations could best be carried out in conjunction with existing research institutions, and that the organization of additional laboratories should not, therefore, be included in the functions of the new Bureaux.

The Conference also recommended the establishment of Imperial clearing houses on a smaller scale—"Correspondence Centres"—for animal genetics, agricultural parasitology, plant genetics, and fruit production.

In order to give effect to these plans, the Conference recommended that, when the assent of the respective Governments to the proposals had been signified, a financial supervisory body should be appointed. This body was duly called together, and held a series of meetings in London in November, 1928, when a report was prepared describing the functions which the clearing houses would perform, their general methods of work, and the manner in which they should be financed and administered. Copies of the report have been submitted to the respective Governments for approval. The Commonwealth Government has already signified its willingness to participate in the scheme and to provide its financial contributions for a period of five years.

2. General Effect of Scheme.

In preparing its report, the supervisory financial body kept three important considerations in view, viz., (i) the observance in practice of the general principles enunciated at the Imperial Conference, 1926, whereby each of the contributing Governments should have an effective and equal voice in the control of the new clearing houses; (ii) the need for securing the greatest co-operation in the development of each science between the research workers in all parts of the Empire; and (iii) the need for devising a scheme acceptable to the Institutions to which it is proposed to attach the clearing houses.

The general effect of the scheme is that the clearing houses will be financed from a common fund controlled by a Council representing the contributing Governments, and will be administered in such a manner that their identities are not merged in those of the Institutions at which they are located. Thus, the principle of Imperial co-operation and of a common Imperial responsibility will be applied in practice, and at the same time confidence in the utility of these clearing houses will be secured by their close association with well-recognised Institutions. Their final success will depend on the collaboration forthcoming from research workers in each branch of science in all parts of the Empire. It is not sufficient to ask for help; it is necessary also to give. It is hoped that, not only the official correspondents, but also research workers generally, will collaborate in the preparation of material required by these clearing houses of information. If the idea with which they have been conceived is realized, research work undertaken throughout the Empire is bound to gain in value and effect.

3. The New Bureaux.

As the distinction drawn at the Imperial Agricultural Research Conference, in 1927, between "bureaux" and "correspondence centres" turned, not on differences in functions, but on differences of scale, it has been decided to call all the clearing houses bureaux, observing in the financial allotments made to them the discrimination recommended by the Imperial Agricultural Research Conference. It is accordingly proposed to establish the eight new bureaux specified below, and it is intended that the first three, namely, the Imperial Bureaux of Soil Science, Animal Nutrition, and Animal Health should, for the present, be organized on a larger scale than the other five.

Name.	Location.
The Imperial Bureau of—	*To be attached to the—*
Soil Science	Rothamsted Experimental Station, Harpenden, Herts, England
Animal Nutrition ..	Rowett Research Institute, Bucksburn, Aberdeen, Scotland
Animal Health	Veterinary Research Laboratory, Weybridge, Surrey, England
Animal Genetics	Animal Breeding Research Department, Edinburgh University, Scotland
Agricultural Parasitology	Institute of Agricultural Parasitology, near St. Albans, England
Plant Genetics (for crops other than herbage plants)	Plant Breeding Institute, Cambridge University, England
Plant genetics (for herbage plants)	Welsh Plant Breeding Station, Aberystwyth, Wales
Fruit Production ..	East Malling Research Station, East Malling, Kent, England

4. Their Functions.

The purposes which the new Bureaux are expected to serve are specified in the report of the supervisory body, and are as follow:—

A.—Collection of Information.

(i) A Bureau should maintain an index of research being carried out in different parts of the Empire, and, as far as practicable, in foreign countries.

(ii) A Bureau should begin by collecting, abstracting, and collating information from all sources bearing on the most important problems under investigation in different parts of the Empire, but care should be taken to avoid the collection of uncorrelated data.

(iii) A Bureau should keep itself informed of the general progress of research work within its province in different parts of the Empire.

(iv) A Bureau should, in appropriate cases, summarize available statistics where these are of importance in connexion with its work.

B.—Distribution of Information.

(i) A Bureau should supply, on request, information within the scope of its work to officials and advisory officers in all parts of the Empire. Where a Bureau is not in possession of such information, it should endeavour to put the inquirer in touch with the best source.

(ii) Where feasible, a Bureau should supply to research workers in the Empire, on request, information, including bibliographies and photostat prints of articles on specific problems.

(iii) A Bureau should issue informaton along such lines as may be deemed desirable by the Executive Council.

C.—PUBLICATION.

The general distribution of information (apart from the distribution of information to particular individuals) is part of the duties of a Bureau, but the publication of special monographs should only be made with the approval of the Executive Council, and though in many cases it may ultimately be found desirable to establish a journal, such publication should not, on account of its permanent cost, be undertaken until the Bureau has become fully established, and then only on the authorization of the Executive Council.

D.—GENERAL.

A Bureau should not undertake any laboratory or field research work involving expense, but, in addition to its main function of facilitating the exchange of information, a Bureau will be in a position to be of service to research workers in various ways, and especially along the following lines:—

(i) By facilitating exchange of workers, especially by supplying information in regard to centres between which exchange would be most profitable.

(ii) By facilitating, through correspondence or otherwise, meetings at the most convenient centres of workers interested in the same problems in different parts of the Empire.

(iii) By facilitating the exchange of experimental material for research purposes between institutions or workers in different parts of the Empire.

(iv) By supplying information on the best centres for post-graduate study, the best sources of supply of apparatus or equipment, and any other such information of a general character which might be of service to institutions or individual workers.

5. Official Correspondents.

The Imperial Agricultural Research Conference advocated the association with each Bureau of specialists in the appropriate science in each country. Effect has been given to this recommendation by providing in the scheme for "Official Correspondents." Specialists in the appropriate branches of science will be nominated by the Governments concerned as Official Correspondents—one by each Government for each Bureau. In each country, the representative of the Bureau will be the Official Correspondent, to whom the Director may turn for such help as he may require, and from whom he may obtain suggestions regarding the work and activity of the Bureau.

It is expected that these Correspondents will make it their duty to take a keen interest in the functions and work of the Bureau, and facilitate its activities in the interest of research workers in the Empire as a whole.

6. Finance.

The estimated cost of the whole scheme is £20,000 per annum. The contributions proposed annually from the Governments concerned are as follow:—

	£	s.	d.
The United Kingdom	3,750	0	0
The Colonial Office	3,750	0	0
Canada	3,125	0	0
Australia	3,125	0	0
India	2,187	10	0
The Union of South Africa	1,562	10	0
New Zealand	1,250	0	0
Irish Free State	625	0	0
Southern Rhodesia	250	0	0
Anglo-Egyptian Sudan	250	0	0
Newfoundland	125	0	0
Total	£20,000	0	0

7. The Executive Council.

The control of the funds, their distribution among the several Bureaux, and the general administration and supervision of the scheme, will be in the hands of a supervisory body, which is to be known as the Executive Council of the Imperial Agricultural Bureaux, and which will consist of representatives of the Governments contributing towards the cost of the scheme.

Whilst it is confidently expected that the soundness of the scheme will be demonstrated in practice, yet it is recognised that the proposals may have to be modified in the light of experience, or to meet the needs of a particular science. The meetings of the Imperial Agricultural Research Conference, and any special meetings of those engaged in a particular science, will afford opportunities for adjustment of differences of view regarding the work to be undertaken by the Bureaux.

The Refrigeration of Fish.

By W. J. Young, D.Sc., and W. A. Empey, B.V.Sc.

(Report of investigations carried out at the Biochemical Department of the University of Melbourne, on behalf of the Meat Freezing Committee of the Australian National Research Council and of the Council for Scientific and Industrial Research.)

1. Introduction.

It is a common belief amongst those engaged in the fish industry of Australia that Australian fish deteriorate when stored in the frozen condition; they are said to lose weight and shrivel up, even if covered with an ice glazing.

Shock methods of freezing fish are successfully employed in Europe and America, where fish frozen by such methods is commonly kept in cold storage for long periods without much deterioration.

A report by Styles[1] on the freezing of fish was published by the Food Investigation Board of Great Britain in 1922. The general conclusions arrived at in this report were to the effect that fish frozen rapidly in brine underwent much less change in the tissues than fish frozen more slowly in air, and it was considered that the brine-freezing process was applicable to all species of fish.

2. Freezing.

An opportunity arose of comparing both these methods of freezing on Australian fish, and the following investigation was undertaken with this object. Two kinds of fish were employed—schnapper and bay flathead—and the freezing was commenced about 24 hours after catching, and without any preliminary washing, scaling, or gutting. During the 24-hour period the fish had been kept packed in ice.

The methods adopted for freezing the fish closely followed those of the well-known Ottesen process, in which a concentrated sodium chloride solution containing also glycerine is used, and the mixture is cooled by ammonia expansion coils immersed in an insulated tank and circulated by a paddle. The concentration of the brine is such that ice is just separating out at the temperature employed, and it is stated that under these conditions the penetration of salt into the material is at a minimum. In this investigation, the brine was kept at 8 deg. Fahr. The fish, contained in a wire basket, was immersed in the brine for twenty minutes in the case of flathead, and sixty in that of schnapper. The basket of fish was then removed and quickly dipped into water at ordinary temperatures to wash off any adhering brine, and the fish was then ready for storage.

The ordinary method of freezing in air was applied to other fish, which were placed in a cold room at 10 deg. Fahr. The time taken to freeze was fourteen hours for the flathead and twenty hours for the schnapper.

The whole of the fish was wrapped in parchment paper and stored in boxes, which were also lined with the same paper, and held in a room at 10 deg. Fahr. Samples of both lots were taken at intervals up to twelve months and examined for loss of weight; they were then thawed out and compared for general appearance, and in some cases cooking tests were made.

3. Glazing.

Immediately after freezing, samples of each kind of fish frozen by the two methods were glazed with a coating of ice by dipping for a few seconds into tap water at 35 deg. Fahr. The thickness of glaze could be increased by repeating this process. In applying the glaze it was found, as already stated by Taylor,[2] that a more uniform coating of ice was produced with the water at 35 deg. F. than at lower temperatures, such as 32 deg. or 33 deg. F. The glaze gradually evaporated during storage, and reglazing was found necessary at intervals of approximately 40 days. It was found that, with one exception, the ice glaze evaporated more slowly from the brine-frozen than from the air-frozen fish. This one exception was with the original glazing, and in every case with glazings subsequently applied during storage evaporation was more rapid from the air-frozen specimens. This observation was made by noting the loss of weight of the glazed fish. That this loss was due to loss of glaze was shown by the fact that when the glaze was removed without thawing the fish the latter weighed the same as in the original frozen state. It is difficult to account for this phenomenon.

4. Appearance.

(*a*) *In the Frozen State.*—Immediately after freezing, the fish frozen in air had lost its sheen and surface mucilage, and presented a much duller appearance than the fresh fish. This was more noticeable with flathead than with schnapper. The brine-frozen fish, on the other hand, retained their colour, sheen, and mucilage, and had a more natural appearance than the air-frozen fish.

In both cases the eyes were opaque. Only a slight darkening in colour had occurred in the gills of the brine-frozen fish, whilst those of the fish frozen in air had become distinctly brown. This change in colour of the gills was found to be due to a change in the red blood pigment hæmoglobin to brown methæmoglobin. The latter pigment was always found in the gills of fish which had been kept for some time.

During storage, a gradual deterioration in appearance took place with all fish which had not been glazed, and, after about a month, fish frozen by both methods were almost indistinguishable in appearance. After storage for twelve months, they presented a shrivelled and dull surface; the eyes had shrunk considerably, and the gills were all brown in colour. The loss in water was mainly from the superficial layers, and the moisture-content of the deep layers did not show any marked diminution from that of fresh fish.

If the fish were kept continually glazed, there was not any great change in appearance during storage, excepting that the gills became browner in all cases. Thus, after storage for twelve months, the brine-frozen fish presented a much more natural appearance than the air-frozen. A very marked difference in texture between fish frozen in

brine and in air was observed when the fish was cut in the frozen condition. The brine-frozen fish cut fairly easily, showing a uniform waxy consistency, whilst the air-frozen was hard and brittle, and much more difficult to cut. This difference was especially noticeable when thin sections were cut with a razor for microscopical examination, and was due to the larger ice crystals in the air-frozen fish, which damaged the edge of the razor. This difference has been noted by other investigators.

(*b*) *After Thawing.*—With the glazed fish, thawing was brought about in water at 55 deg. F. to 65 deg. F., the schnapper requiring three hours and the flathead one hour for completion of thawing.

When thawed, the brine-frozen fish were bright in appearance, and the eyes had lost most of their opacity, except in the lens, which was still slightly opaque. The gills were of a light reddish-brown colour, and the blood was darker than that of fresh fish. When cut, the flesh was firm and white, with no discoloration in the vicinity of the backbone or gills. The abdominal contents appeared normal.

The air-frozen fish were not so attractive in appearance. The gills were brown and the eyes more opaque. The flesh was soft and flabby, and pitted easily with the fingers. When cut, the flesh appeared duller in colour, softer, and in the vicinity of the backbone there was a reddish-brown discoloration of the tissues. The gut contents were darker in colour than in the brine-frozen fish. The ooze of juice from cut surfaces of muscle was much more marked in the case of the air-frozen fish.

The backbones of a brine-frozen and air-frozen fish with some of the attached flesh were exposed side by side in air for 24 hours. At the end of this time the discoloration and softening of the muscle tissue in the one that had been air-frozen had increased considerably, whereas the other still retained its firmness and whiteness. The unanimous opinion of a number of people trained in buying fish, and who saw samples of flathead and schnapper which had been frozen by both methods, and which had been in cold store for seven and twelve months, was that the brine-frozen fish was much better in appearance and texture than the air frozen.

Fresh fish when compared with the thawed fish was better in appearance as regards the colour of the gills, condition of the eyes, and sheen of the skin, but the brine-frozen were superior to the air-frozen in every case. On cutting, it was observed that the brine-frozen fish was firmer than the fresh fish, as had already been recorded by Taylor (*loc. cit.*).

When the thawed fish was kept alongside fresh fish, it was noted that that which had been frozen in brine resisted decomposition for a longer time than the fresh fish, whereas the air-frozen showed no resistance. This confirms the statements of other observers (Taylor, Stiles), who have attributed the capacity for resistance to a sterilizing action of the cold brine.

The unglazed fish, which had become shrivelled through long storage, improved very much in appearance when thawed in water, because of the absorption of water by the surface layers, and the eyes were not now so shrunken. After thawing, there was not much difference in the superficial appearance, except for the fact that the air-frozen fish were covered with patches of ropy mucilage. On cutting, however, the air-frozen fish showed a much more spongy texture, and the juice could be easily pressed out.

5. Changes in Weight.

The following table shows the percentage losses in weight during the actual freezing process and after varying periods of storage in the unglazed state, of batches of fish frozen by both methods and subsequently stored in parchment paper coverings inside boxes:—

TABLE 1.

Percentage Losses of Weight in Stored Fish.

—	Brine Frozen.		Air Frozen.	
	Schnapper.	Flathead.	Schnapper	Flathead.
During freezing	0	0	1·5	5·3
After 3 weeks' storage ..	5·5	9·6	10·1	11·9
After 12 weeks' storage ..	8·2	11·3	15·8	19·9
After 22 weeks' storage ..	13·2	17·8	18·1	21·7
After 52 weeks' storage ..	19·0	24·3	23·4	28·1

The original weights of the fish before freezing were—

	lb.	oz.
Brine-frozen schnapper	6	10
Brine-frozen flathead	5	11
Air-frozen schnapper	3	5½
Air-frozen flathead	5	7½

It will be observed that the greater loss from the air-frozen fish is mainly due to the fact that a certain amount of loss occurred during the freezing in air, whereas there was no such loss with the brine. If the fish were thawed by immersion in water, approximately half of this loss was recovered, but when thawed in air there was no such recovery.

The fish which had been kept glazed were weighed after a rapid removal of the glaze with hot water. This could readily be done without thawing the fish, and it was found that practically no loss had occurred even after prolonged storage of either air-frozen or brine-frozen fish. The results indicate that loss of weight by evaporation is easily prevented by keeping the fish coated with a glaze of ice.

6. Cooking Tests.

Samples of both flathead and schnapper frozen by both methods, and which had been kept glazed throughout storage, were taken at intervals of seven, nine, and twelve months, thawed in water, and cooked. At the same time, portions of fresh fish were cooked for comparison.

The fish was tasted by a number of persons, whose opinions were given without any knowledge of the identity of the fish. The cooking was carried out by students of the Emily McPherson College of Domestic Economy, Melbourne, who also gave opinions on the general condition of the uncooked fish.

The decision expressed in every case was that the brine-frozen fish approached more closely to the fresh fish, and was greatly superior to the air-frozen samples, although not quite so saleable in appearance

as the fresh. It had firm flesh, which filleted well, whereas the air-frozen fish was soft and flabby, and difficult to fillet without breaking.

With regard to the edibility of the cooked fish, both schnapper and flathead, in every test there was a difference of opinion as to whether the fresh fish or the brine-frozen fish was the better, but the air-frozen fish was unanimously considered as inferior to both. In addition, other fish, including whiting and flounder, which had been frozen in brine and stored for periods of a few days up to one month, were cooked and eaten by other persons, and, in every case were pronounced equal to fresh fish.

7. Penetration of Salt.

Although there was no evidence in the taste of the fish of any penetration of salt into the flesh, it was thought advisable to determine the amount of sodium chloride in the flesh of fish frozen by the two methods and in fresh fish. This was done by drying and ashing a weighed quantity, care being taken that the temperature did not rise too high, and estimating the chloride in the ash with silver nitrate. The following figures represent sodium chloride per 100 parts of fish, and have been calculated for the original weight of the fish:—

TABLE 2.

Content of Sodium Chloride in Flesh of Fish.

—		Schnapper.		Flathead.	
Fresh		0·0134 0·0138 0·0146 0·0126	Average 0·014	0.0130 0.0100 0·0140 0·0138 0·0134 0·0138	Average 0·013
Air Frozen		0·020 0·0117	Average 0·016	0·0136 0·0130	Average 0·013
Brine Frozen ..	At surface of fish	0·062 0·062	Average 0·062	0·192 0·170 0·163	Average 0·175
	At centre of fish	0·020 0·030	Average 0·025	0·102 0·112 0·092	Average 0·102

The absorption of salt per 100 parts of fish by the brine-frozen fish calculated from the above figures is as follows:—

	Surface.	Centre.
Brine-frozen schnapper	0.048 ..	0.011
Brine-frozen flathead	0.162 ..	0.089

These figures would be equivalent to one part of salt to 2,083 parts of fish on the surface of the brine-frozen schnapper, and one part of salt to 9,090 parts of fish in the centre. In the brine-frozen flathead the proportions of salt absorbed would be one part in 617 for the surface, and one part in 1,124 for the centre. The penetration of salt into the flesh is therefore insignificant.

8. Histological.

Periodical microscopical examinations of the fish in the frozen state were made by cutting thin sections with a sharp razor and examining under the microscope in a room at 10 deg. F. In addition, sections were fixed and dehydrated in the cold room, then brought to 40 deg. F., and stained in the usual manner. Photomicrographs were taken of the frozen sections.

The size of the ice crystals present in the still frozen sections was determined by measuring the average diameter of a number of ice crystals, which were easily distinguishable from muscle fibres under the microscope.

In the air-frozen fish ice crystals occupied more than half of the total area of a section, and their average diameter was 200 microns. In the brine-frozen fish ice crystals were almost absent, and only an isolated one with a diamter of about 40 microns was occasionally found. This difference in ice crystal formation is clearly shown in the photomicrographs. (Plates 2 and 3.)

In the fish glazed and reglazed during storage there was no alteration in the histological structure with the progress of storage, but in the unglazed fish, where evaporation had occurred, there was a diminution in the size of the ice crystals, chiefly near the surface of the fish.

The photomicrographs (see Plates 2 and 3, Figs. 1 to 10), which were all taken from frozen sections of glazed fish after ten months' storage, show clearly the differences in structure between the fish frozen by the two different methods.

Fig. 1 represents a cross-section of brine-frozen schnapper in which there is a close resemblance to normal unfrozen fish muscle. The individual fibres are uniformly grouped, and have retained their normal cylindrical and polygonal shape, as in fresh muscle tissue. In a few isolated places, such as at A, indications of commencing ice crystal formation are seen.

Fig. 2 represents a cross-section of air-frozen schnapper, showing clearly the extensive formation of ice crystals, which occupy more than half the total area of the section. The muscle fibres and connective tissue have been compressed into bundles between the ice crystals, giving an appearance quite unlike that of a normal unfrozen section.

Fig. 3 shows a longitudinal section of brine-frozen schnapper.

Fig. 4 shows a longitudinal section of air-frozen schnapper.

The differences between these two longitudinal sections are similar to those noted in the cross-sections.

Figs. 5 *and* 7 represent cross and longitudinal sections of brine-frozen flathead.

Figs. 6 *and* 8 represent cross and longitudinal sections of air-frozen flathead. The differences in structure of these sections of flathead are similar to those of schnapper.

Figs. 9 *and* 10 show respectively longitudinal sections of brine-frozen and air-frozen flathead, the sections having been fixed and dehydrated in the room at 18 deg. F., and stained with hæmatoxylin and eosin after removal to a temperature of 40 deg. F.

The brine-frozen section shows no apparent change from the normal arrangement of the muscle fibres, whereras the air-frozen section shows the distortion of muscle fibres and their compression into bands, between which are the spaces originally occupied by ice crystals.

Fig. 11 shows a longitudinal section of normal fresh fish muscle taken from a flathead.

The magnification used in all the photomicrographs is 70 diameters.*

9. Summary.

1. Fish frozen both rapidly in brine and slowly in air were kept in cold storage for periods up to twelve months, and compared with the fresh fish of the same species for appearance, loss of weight, and edibility.

2. In the case of the air-frozen fish there was a small loss in weight during the actual process of freezing, which did not occur with the fish frozen in brine.

3. All the fish were found to lose weight, to shrivel up, and deteriorate in appearance during cold storage when protected only by a parchment paper wrapping. When protected, however, by glazing with a film of ice renewed from time to time during storage, there was no loss in weight nor any shrivelling of the flesh of fish frozen by either method, even after storage for twelve months.

It is, therefore, essential that fish which has to be stored in the frozen condition should be kept glazed with ice. This could be very easily done commercially by dipping the fish periodically in water at about 35 deg. F.

4. With fish which had been glazed, that frozen in brine was much superior to the air-frozen fish in appearance, firmness of flesh, and edibility. The difference in texture was due to the very small ice crystal formation in the flesh of the fish frozen more rapidly in brine, whilst the air-frozen fish showed large ice crystals which damaged the muscle fibre and caused the spongy condition found on thawing. The latter after thawing showed much more liquid oozing from a freshly-cut surface. The brine-frozen fish after thawing did not present quite as good an appearance as fresh fish; the gills were slightly brown, especially after long storage, and the lens of the eye was opaque. After dressing and cooking, however, it was indistinguishable from fresh fish in appearance and flavour even after twelve months' storage.

5. The penetration of salt into the flesh of the brine-frozen fish was insignificant.

Acknowledgment.

The authors desire to acknowledge the help afforded them by Mr. J. Hepburn, Works Manager and Chief Engineer, Victorian Government Cool Stores, who made the arrangements for the necessary refrigerating facilities.

10. References.

1. British Food Investigation Board, Special Report, No. 7.

2. Taylor, Harden F., "Refrigeration of Fish," U.S. Department of Commerce, Bureau of Fisheries, Document No. 1016.

* Prior to the production of the blocks for the illustrations.

Division of Economic Botany: Some Present Activities.

The paragraphs that follow have been prepared from a progress report drafted by Dr. B. T. Dickson, Chief of the Division of Economic Botany, for submission to the meeting of the full Council held in March, 1929.—Ed.

After dealing with the various additions to the staff that had been made during the period under review, Dr. Dickson discussed some of the more important problems under investigation by the Division.

1. "Water Blister" of Pineapples.

In June, 1928, at the suggestion of Dr. Rivett, pursuant to a request of the Hon. W. Forgan Smith, Minister for Agriculture for Queensland, Dr. Dickson visited pineapple plantations in order to look into a disease known as "water blister," which annually was the cause of a serious loss to growers.

It was ascertained that the trouble was prevalent in the period November-April, but even those growers who realized that there was an actual condition known as water blister could not give any definite symptoms beyond the fact that the pineapples leaked juice and became either dried mummies or a wet mass useless for sale. No field signs or symptoms were known by which susceptible plants or pines could be determined. As a result, it was decided to await the favorable season, and then to initiate studies at the market end with a view to correlating market with field conditions.

The first authentic specimens of the disease were received from Messrs. Stimson & Firth, of Sydney, and it was at once evident that the so-called water blister was a soft or wet rot. It was ascertained that the fungus *Thielaviopsis paradoxa*—a common soil-borne organism on pineapple areas—was the cause of the disease.

Many consignments of commercial fruit were examined at the Sydney Market during the months of February and March, in order to gain some idea of prevalence, effect on the fruit, &c. It was found that approximately 80 per cent. of the infected pines were basally infected, which is not unexpected when one recalls that the fungus is soil-borne.

The fungus grows rapidly at ordinary temperatures, but is checked by high (37 deg. C.) and low (10 deg. C.) temperatures. If entry occurs at the base, the *Thielaviopsis* spreads quickly up the vascular system and thence to the pulp, in which resulting cell breakdown releases large quantities of juice. This drips from the pines and fermentation may play a part in the final stages of the general collapse of the fruit, as yeasts are present on the surface, and, of course, in the air. Sometimes the organism is found as a black growth on the outside of the pine where it has been cut or broken. On opening a pine, one notices first the water-affected area, usually sharply delimited, and the olive-green discoloration of the heavily infected zone. This discoloration speedily intensifies until it is quite black, due to the darkening of the mycelium and the development of heavy-walled, dark-coloured spores. These are the spores, which can live over adverse periods in the soil. Another smaller, paler spore is also developed, but this type is less resistant and less long lived. Tests so far conducted indicate

that this spore germinates in four hours—a matter of some importance when attempting control measures. Technical studies on the organism will be carried on during the winter and spring, in order to ascertain all possible facts regarding its life history.

A questionnaire to fruit merchants has brought to light the fact that this trouble has been known for fifteen years or more, and that it gives rise to an annual loss of about 10 per cent., computed by the Committee of Direction of Fruit Marketing, Queensland, at about £7,000, plus some £500-£600 transportation costs of the diseased fruit. The disease is at its height chiefly during the months of January-March.

Experiments to determine the most satisfactory control measures are in progress, and will be detailed in a later report. The Plant Pathologist of the Queensland State Department of Agriculture and Stock (Mr. J. H. Simmonds) is co-operating by carrying out experimental control tests in Queensland, and the above Committee of Direction, through Mr. W. Ranger, has co-operated by allocating up to 100 cases of pineapples for the investigation.

2. Tomato Wilt.

This co-operative investigation is proceeding with concentration of effort at the Waite Agricultural Research Institute, where Mr. Samuel, Plant Pathologist of the Institute, is assisted by Mr. Bald, a Junior Plant Pathologist of the Division. The discovery made there, that this virus disease was transmitted by thrips, has necessitated experiments in thrips culture, in order to enable the investigators to be sure of pure cultures for use in infection studies. Both investigators have visited tomato-growing areas in States other than South Australia, and have been able to obtain an amount of correlation between the extent of the disease and the existence in the areas of a certain variety of thrips. It is hoped to prepare a full report on this work at a comparatively early date.

3. Bitter Pit of Apples.

As a result of co-operative investigations undertaken in Western Australia during 1928 between the State Department of Agriculture and the Council, Messrs. W. M. Carne, H. A. Pittman, and H. Elliott were enabled to present evidence regarding the origin of bitter pit, and to make recommendations regarding picking and storage in order to reduce losses. Bulletin No. 41 of the Council by these authors contains an historical *résumé* of the previous studies on bitter pit, a differentiation between true bitter pit and cork, evidence to relate picking maturity and the later development of pit in storage, and a suggested method by which the stage of maturity may be readily ascertained in the orchard.

During the present season, Messrs. Carne and Pittman are working in an Illawarra orchard, at Karragullen, making weekly measurements of 300 Cleopatra and 250 Yates fruits in order to test the relation between growth and maturity. Picking and storage tests are being made again to check picking maturity and the incidence of pitting in storage. Freezing-point and osmotic-pressure determinations of the sap of Dunn's Cleopatra and Granny Smith leaves and fruits are being made at the University of Western Australia.

In Tasmania, an orchard has been selected at Huonville, and the Director of Agriculture is having apples picked and placed in cold storage in order to check, in Tasmania, the results obtained last season in Western Australia. These will be examined in June. In Western Australia, Mr. Carne is co-operating with Mr. Wickens on the inspection of fruit for export.

4. Blue Mould of Tobacco.

In the study of blue mould of tobacco the Division of Economic Botany is co-operating with the Australian Tobacco Investigation. On Dr. Angell's appointment as Senior Pathologist on 22nd December, 1928, he was assigned this problem. With a view to getting acquainted with its various aspects, and in order to formulate a plan of attack, he has visited the Myrtleford district, in Victoria, twice, and also Tamworth, New South Wales, and Mareeba, Queensland. During these visits, other diseases, especially one involving the stems, seemed worthy of study. Preliminary work on them is in progress in the temporary laboratories of the Division at the Botany School of the University of Sydney, and plans are being made to conduct field experiments during the coming season at Canberra, Federal Capital Territory, and either in the tobacco districts around Myrtleford, Victoria, Tumut, New South Wales, or both. It is expected that co-operative work on the blue mould problem will be arranged between the Australian Tobacco Investigation, the C.S.I.R., and State Departments preparatory to the forthcoming growing season.

5. Noogoora Burr (Xanthium strumarium).

Supposedly introduced in the early '60's in cotton seed, this cocklebur covered some 500 acres of the Noogoora Station, near Brisbane, by 1879. From thence it spread, and hence its common name. It is a noxious weed, poisonous to stock, and is spread by animals and flood waters. It is, under pastoral conditions, spreading at an alarming rate in some areas, and undoubtedly constitutes a serious problem. Botanically, it is an annual, developing double-seeded burrs, one seed germinating one season and the other the next, or possibly one in the first part of the season and the second after the wet period. The present intentions regarding the investigation of the problem are discussed elsewhere (see page 116).

6. Report on the Work at Koonamore.*

The work at the Koonamore Vegetation Reserve may be considered under headings of—(*a*) work upon the reserve itself, (*b*) work upon the surrounding station paddocks.

(*a*) *Work upon the Reserve.*—This has followed the lines laid down from the opening of the investigation. The usual quarterly mappings of the quadrats and photographs were taken in December and in March. The last six months has been a dry period in the north-east portion of South Australia. The whole district bears evidence of drought, and on much of the country between Koonamore and the railway wind erosion is worse than I have seen it before. However,

* This work, the objects of which have been described previously (this Journal Vol. 1), is being carried out in co-operation with the University of Adelaide. It was initiated by Professor T. G. B. Osborn when he was an officer of that organization.

in spite of the superficial appearance of drought, the re-mapping of the hectare quadrats showed that salt bushes are appearing in increasing numbers upon all four of these areas.

(*b*) *Work upon the Surrounding Station Paddocks.*—Mr. Paltridge has run about 24 transects from different wells in various parts of the surrounding country. The transect lines have been in general from 1,000 to 1,800 paces in length. In making a transect, the number of salt bushes actually cut by the line of march is noted, also the size of the bush, its vigour, and other points relative to the effect of grazing thereon. In each case the figures obtained by any transect have been checked by counts taken at some portion of the paddock at least 3 miles from the nearest watering place, the object of these latter "open" transects being to obtain notes on the number and vigour of bushes at such a distance from water that they are seldom grazed. It is too early to formulate any definite conclusions from the figures obtained, but there is an indication that reasonable stocking is actually beneficial to the vigour of salt bushes. Such a conclusion, however, is purely tentative, and will have to be checked most carefully by results on further transects to be made during the next quarter.

7. Plant Disease Survey.

In order to be able to arrive at some fairly accurate estimates of the losses resulting from plant diseases, it is necessary to have as complete a picture as possible of the occurrence of diseases in Australia. This involves records of the first appearance of the disease, of the conditions of incidence each year, the geographical distribution, and the severity of the attack, and so on.

Mr. Brittlebank is now engaged in the recording of facts made available by the courtesy and co-operation of Dr. S. S. Cameron and the Victorian Department of Agriculture as the first instalment of the scheme.

8. Botanical Investigations at Merbein.

A complete botanical survey has been made of a virgin area of about 26 acres at the Merbein Research Station. This land will later be laid down as a vineyard, in order to study salting under irrigation.

Work is in progress dealing with the root system of vines under irrigation and with bud development.

Soils Investigations: Progress Report.*

By Professor J. A. Prescott, Professor of Agricultural Chemistry, Waite Agricultural Research Institute, University of Adelaide, and Adviser to the Council on Soil Problems.

The Commonwealth Soils Investigations are now sufficiently developed to allow of some perspective being obtained with regard to their progress, and possible future development. At present, on the Murray River investigations, four men are engaged. The past few months have represented a transition period pending the completion of the laboratory at Griffith, and the effective occupation of the Melrose Laboratory at the Waite Institute. The Griffith Laboratory is as yet barely in working order, and the soil chemist there, Mr. H. N. England, has been collecting and correlating existing information regarding the distribution of the major soil types, and has spent much time in setting up the equipment in the new laboratory. Owing to the somewhat broad field of work available in the Murrumbidgee irrigation area, and to avoid the scattering of too much energy, the immediate project selected has been a detailed scientific investigation of the soil type known as "crab-hole." The distribution of this type within the area will be mapped, and, apart from the chemical and physical work, the ecological relationships and agricultural development of the type will be studied.

Mr. J. K. Taylor, the senior soil survey officer, has now completed two units of field work—a report on the first, at Renmark, is ready for publication. The laboratory work was carried out by Mr. England, then at the Waite Institute. The second unit, at Woorinen, was carried out in collaboration with the Chemist's Branch of the Victorian Department of Agriculture, and much of the chemical work is now complete. These two areas presented problems of a very different character, the only common feature being a wide diversity of type within a limited area. Only one soil type was common to both areas. The investigation at Renmark has provided data of great value to the Irrigation Commissioners, and from the scientific point of view, has thrown interesting light on the origin of the alluvial terraces of the river valley in the Renmark area. The Royal Australian Air Force has also co-operated in this work, and officers of the Force have completed an aerial photographic survey of the area. When these photographs are made available, it is intended to extend the survey from the known area at Block E, to the unknown area of old Renmark.

Mr. Taylor has now begun the field survey of the Lower Murray swamps—a soil type quite different from any previously studied—the field work in this case is of a relatively simple character, and it is expected to present fewer difficulties than were experienced at Renmark or Woorinen. The chemical work will take up some considerable time, however, and Mr. H. G. Poole—soil chemist to the investigation—will devote much attention during the next few months to a study of the soil problems involved.

Mr. Poole, who was appointed some five months ago, is at present engaged in a re-standardization of technique, owing to the recent adoption by British workers of international units in mechanical analysis. Mr. R. J. Best, physical chemist of the University staff at the Waite

* Progress report prepared for submission to meeting of Council, March, 1929.

Institute, has recently worked out a new rapid method for the determination of chlorides in soil which will prove of great service in the work of soil investigation in the irrigated areas.

In order to provide an understudy for Mr. Taylor, steps were taken to secure a graduate in agriculture. After some difficulty and delay in finding a suitable candidate, Mr. T. J. Marshall, a recent graduate of Western Australia, has been appointed as assistant field officer. After a short period at the Waite Institute, Mr. Marshall will join the field party at Murray Bridge.

Further possibilities of soil research in the irrigated areas were discussed with Sir John Russell in July, 1928. An Empire Marketing Board scheme of co-operative investigation with the Rothamsted workers has been projected, but no developments are expected until the Irrigation Sub-Committee appointed by the Imperial Government has reported on the whole question of Imperial irrigation research.

The details of co-operative investigation on certain soil problems of Tasmania have been recently finalized. The Tasmanian Department of Agriculture and the University of Tasmania are concerned. Mr. Stephens, a graduate working under the supervision of Professor McAulay, will spend a short period of training at the Waite Institute in physical and physico-chemical methods as applied to soil work. The subject for study has been defined as: "The orchard soils of the Huon Valley."

Possibilities of co-ordination in broader aspects of soil survey work in Western Australia and Queensland have also been explored, but no definite steps have yet been taken.

Further possibilities of the work at the Waite Institute include the broadening of the scope of the soil work to include problems outside the irrigation areas. A number of soil problems arising directly out of the work of the Division of Animal Nutrition are already worthy of immediate consideration, and these include systematic work on the soils of the field stations and soil surveys for sulphur and iodine content.

The Production of Fruit Drinks from Apricots, Peaches, Etc.

By S. R. de Pasquale, B.Sc. (Messina, Italy), Manager of the Research Department, O. T. Co. Ltd., Melbourne.

Towards the end of 1928, the Council was asked by several fruit-growing interests as to whether anything could be done with waste peaches, apricots, &c., during glut periods. As the matter appeared to be very closely connected with economic considerations, and as the Development and Migration Commission had already made extensive inquiries into the fruit-growing industry from the point of view of canning, the requests were discussed with the Commission. As a result, it was decided that both bodies would co-operate in an inquiry into the possibilities of the utilization of the fruit in question as a raw material for the production of fruit drinks. By the kindness of Messrs. O.T. Co. Ltd., Melbourne, arrangements were subsequently made for the actual experimental work involved to be carried out at the company's factory by Mr. S. R. de Pasquale, B.Sc., the manager of the company's research department. The company also agreed to do this work gratis. An officer of the Commission, Mr. H. Elford, B.E., had previously been made responsible for the preparation of the programme of investigations from the point of view of the special requirements of the two Government bodies, and also for the attending to the various arrangements that it was necessary to make from time to time. Several sets of samples of the various drinks and cordials made during the experiments have been prepared and distributed to interested parties. The following article is based on a report furnished by Mr. de Pasquale.—Ed.

Apricots, peaches, pears, plums, and nectarines have been experimented with for the purpose of determining whether the succulent portion of the fruit can be satisfactorily used for the manufacture of cordials and beverages.

1. Extraction of the Juice and Pulp.

The fruit used could not be satisfactorily treated for the extraction of the juice and pulp with ordinary presses, or with squeezers of the type usually employed in the treatment of citrus fruit. Fruits belonging to the pomaceous sub-order and to the genus *Prunus*, such as those treated, have an exocarp formed of a thick and fleshy pulp, and the drupes (stone fruit) have a comparatively large stone or pit, which makes impossible the use of any simple squeezing process. In consideration of these facts, the writer, after having washed the fruits and removed the stones, used a process in which the pulpy material was squashed against a mechanical sieve, the film forming the epicarp and the hard portions of the flesh being thereby rejected. The resulting raw material to be subsequently used for the production of the fruit drinks was a very thick fluid, composed of juice, pectin (colloidal matter), and fibrous material. To this raw material the term juice-pulp has been given.

2. Clarifying the Juice Pulp.

On account of the colloidal character of the juice-pulp, and because of the large amount of suspended solid matter present, clarifying was a

laborious and lengthy process. For the same reasons, filtering through a filter press was practically impossible. It would appear that only by removing the pectins could any process of filtering be made workable. Using a fermentation process, the pectins would be destroyed and the solid matters would then separate from the liquid portion. But fermentation would also mean a definite chemical decomposition of the material, in the course of which both flavour and taste would be modified considerably, and the principal characters of the original fruit disguised.

The addition of comparatively inert clarifying agents, such as diatomaceous earth or Spanish clay, which have the power of absorbing the colloidal matters, of carbon, of casein or gelatine, was not successful. With any of the above substances the fibrous matters present in the juice made a separation difficult. In my opinion, the materials mentioned above could be successfully employed if the juice-pulp were previously diluted with an equal amount of water. Such a scheme would involve a re-concentration of the clear juice to its original strength, and this would be a rather costly process.

Considering that pulpy material in cordials and beverages made from fresh fruits has not an unpleasing appearance, in my opinion, their presence would not only be unobjectionable, but would rather be accepted by the general public as a guarantee that real fruits have been employed in the manufacture.

A series of experiments was carried out with a view of determining the keeping qualities of the juice-pulp, and of evolving methods of improving those qualities. In general, the results indicated that the usual methods of preservation would probably be quite satisfactory, although in all cases very careful treatment would be required, and further work would be necessary to determine the precise details of the most suitable procedure.

3. Yield and Character of the Juice Pulp.

The following species of the genus *Prunus* have been treated:—*P. Armeniaca* (apricot), *P. domestica* (plum, var. Burbank Japanese), *P. Persica* (peach, var. Wintere Freestone), and *P. Persica* (nectarine), also the species *Pyrus communis* (pear, var. Williams).

The yield of pulp and stones, together with some of the physical and chemical properties of the different juice-pulps, are set out below:—

Varieties of Fruit.	Yield of Pulp per lb. of Fruit.	Weight of Kernels per lb. of Fruit.	Acidity as Citric Acid.	Specific Gravity at 15° C.	Sugar Calculated from Specific Gravity.	Condition of Fruit.
	Fluid oz.	Oz.	Per cent.		Per cent.	
Apricots ..	13	1·5	1·47	1·042	10	Ripe
Plums ..	12	1·75	1·71	1·024	6	Not quite ripe
Peaches ..	10	2·5	0·88	1·015	4	Ripe
Nectarines ..	9	2·75	0·85	1·027	7	Not all ripe, some over ripe discarded.
Pears ..	13	..	0·25	..	..	Ripe

The specific gravity of the pear juice-pulp was not determined because of its extreme thickness. From the above figures given in the table, it is clear that apricots and pears give the largest amount of pulp per lb. of fruit, and therefore from this aspect are the most economical to use. With regard to the chemical characters, apricots, on account of their well-balanced strength of acid and sugar content, would appear to be the most suitable for cordials and beverages.

It should be pointed out that, in all the fruits under discussion, both the acidity and the sugar contents are rather too low to make a palatable beverage simply by diluting the pulp. To make a drink agreeable to the taste it is necessary, in my opinion, to fortify all the natural characteristics, including the aroma.

4. Utilization of Juice Pulp in Cordials and Beverages.

As the result of numerous experiments, the writer believes it is possible to manufacture from the juice-pulp extracted in the manner previously described, satisfactory drinks either in the form of cordials to be diluted for use, or carbonated ready for use.

Varying quantities of water, sugar, and citric acid have been added to the juice-pulp, and in addition very small amounts of essences, fortifying the natural aroma of the fruits. These additions were found necessary to reduce the thickness of the pulp and to give the cordial or beverage an improved taste and a more agreeable appearance. Both cordials and carbonated beverages possess the true aroma of the fruits, and are, in my opinion, quite satisfactory.

According to the personal taste of the writer, the drinks made from apricots, peaches, and pears are the most agreeable of those made. The cordials and beverages from the plum and nectarine, although not inferior, do not possess such marked characteristics as other fruits experimented with. Drinks made from these two fruits have rather a hybrid taste, which, in my opinion, the general public would possibly not identify or appreciate.

In the event of any of the above drinks being placed on the market, intensive selling propaganda would be necessary. In Australia, the public is at present educated in drinking mostly citrus beverages, and is not likely to change its taste unless special efforts are made.

5. Medicinal and Nourishing Factors.

These factors must not be overlooked, since from the selling point they are very important. If it is true that citrus beverages are thirst quenchers and health givers, then so are the beverages made using the fruits under discussion. In an apricot, or any of the fruits used in the investigation, there is practically all the nourishment necessary to keep man alive. Carbohydrates are plentiful; nitrogenous bodies, such as albuminoids and proteins, are in greater amounts than in lemons and oranges; while there is sufficient acidity to help digestion. Vitamines are also present in an estimable amount. All the above substances would be found also in the cordials and beverages made from these fruits.

6. Concentration of the Juice Pulp.

This matter has been closely studied, and while the writer acknowledges that for export trade concentration of the fruit juice would be of great benefit, he regrets that, having no small plant available, he has been unable to produce samples. He had at his disposal an industrial plant for the production of concentrated fruit juice, but as the minimum working capacity of this plant is at least 100 gallons of fresh pulp at one time, the experiments had to be postponed until a large quantity of raw material is available.

The writer, who has already had personal experience in this matter, being responsible for the introduction in Australia of a successful process for concentrating fruit juices, believes that concentration would present but little difficulty. In the concentration of pulpy juices, the juices must first be clarified, using the process suggested earlier in this report. The question of concentration is very important in itself, and would require study and a series of experiments especially devoted to it.

7. Conclusion.

The experiments carried out as discussed above allow me to set out with confidence the following conclusions:—

1. Apricots, peaches, pears, nectarines, and plums, when a good average quality and in the ripe condition, can supply a fruit juice-pulp that can be commercially extracted.
2. The juice-pulp extracted from apricots, peaches, and pears can be commercially utilized for the manufacture of pure fruit cordials and carbonated beverages.
3. Cordials and beverages made from apricots, peaches, and pears can be successfully preserved.
4. The juice-pulp of apricots, peaches, and pears, can most probably be satisfactorily concentrated.
5. Provided an outlet could be found for the concentrated juice of the above fruits, additional by-products could be manufactured from fruit pits, e.g., sweet and bitter oil of almonds and macaroon paste from the kernels, and high-grade charcoal from the woody portion of the pit. Spoiled or inferior fruit could be utilized for the manufacture of fruit vinegar, and possibly of acetic acid. Considerable experimental work would be required to thoroughly test out the commercial production of the above-mentioned substances.

The Division of Animal Nutrition.

The following article is based on two progress reports recently submitted to the Council by Professor T. Brailsford Robertson, Chief of the Division.—Ed.

I. In the Laboratory.

Wool Analysis.—Regarding wool as a crop which is indirectly derived from the soil through the medium of the sheep, our first care in undertaking the investigation of the nutrition of sheep from the stand-point of wool production was to ascertain the exact composition of wool fibre. The preliminary results of these investigations are embodied in a Bulletin* by Mr. Hedley R. Marston, which has recently been published. Wool fibre is, of course, a protein, but it differs from the majority of proteins in the peculiar assortment of amino acids which contribute to the formation of the molecule. As a result, the production of wool imposes a very special demand upon the nutrition of the sheep. In particular, wool contains 13 per cent. of the amino acid cystine, while fodder proteins and flesh proteins contain, on the average, about 1 per cent. Consequently, to produce 1 lb. of wool fibre it is necessary for the sheep to consume, at least, 13 lb. of fodder proteins. Cystine is not the only amino acid which is present in wool fibre in a proportion unusual in ordinary proteins, but, as it is the amino acid which is most distinctively out of proportion to the others in wool, and as it is an amino acid which is notoriously scarce in foodstuffs, we may suspect with very good reason that the supply of this particular amino acid may frequently constitute a limiting factor in the capacity of a pasture to produce wool. At the present time, intensive work on the proteins of fodder plants and concentrated food-stuffs is being carried out with a view to acquiring knowledge concerning the capacity of various fodder proteins to provide the amino acids required to manufacture wool.

Grasses and Other Fodder Plants.—The grasses and other fodder plants which up to the present date have been prepared for the extraction of proteins from them include the following:—Lucerne, subterranean clover, danthonia, and salt bush (*Atriplex vesicaria*). Fodders which have been partially collected, but of which we have as yet an incomplete study, are Wimmera rye grass, trefoil, and Mitchell grass. These fodders will be studied both biologically and chemically. In the biological tests, which are designed merely to supplement chemical examinations, the protein which we will employ for comparison will be casein, for the reason that this protein is notoriously deficient in cystine, and the minimum of this protein necessary to procure growth is in all animals determined by the amount of cystine.

Concentrated Fodders.—A systematic search is being made for concentrates which are high in cystine content. The cystine content in the proteins of fodder plants rarely exceeds 1 per cent., and protein forms but a small proportion of any fodder plant. As the result of collaboration with industrial interests, the discovery has been made that by suitable treatment of blood, hair, wool, and horn waste, a dried meal can be produced containing 3 per cent. of cystine and superior to blood meal in digestibility and keeping qualities, and also cheaper in production cost. This meal is already upon the market. In addition

* Council for Scientific and Industrial Research, Australia, Bulletin 38 (1928).

to this work on concentrates, an examinaion of a number of plants and plant juices for cystine content is being made, and already it has been demonstrated that the latices of certain plants common in Australia contain an extraordinarily high proportion of cystine.

Estimation of Nucleic Acid.—Nucleic acid is one of the most important forms in which phosphoric acid occurs in animal and plant tissues, but it has hitherto been impossible to determine it quantitatively with any approach to accuracy in adult tissues. We have devised a new method of carrying out this estimation.*

Analysis of Bones and Soils.—Mr. R. G. Thomas has now standardized his methods of bone analysis, and has started work upon an extensive collection of rib bones of sheep obtained in the south-eastern districts of South Australia, where phosphate deficiency in the soil is very marked. The soil samples collected by Mr. Thomas during his geological surveys of our field stations are forwarded to the Waite Agricultural Research Institute, where they are studied and incorporated in the collection which is being formed there.

Analysis of Thyroid Glands.—A survey of the iodine content of thyroid glands of sheep in different parts of Australia falls naturally into two parts. The one consists of analyses of glands obtained from widely distributed areas, only one or a few glands being analysed from each locality. This will serve to reveal any districts which may chance to be notably deficient in iodine. The other consists of analyses of large numbers of glands from a few districts in which our field stations are situated. These analyses enable us to estimate the variability of iodine content in the glands of individual sheep, and to correlate these variations with the condition of the sheep and the quality of wool which it yields. Since the thyroid gland is known to exercise considerable influence on the growth of hair and wool, it is not unlikely that such correlations may exist.

As an instance of the effect of the thyroid on hair production, it might be mentioned that pigs in iodine deficient districts in the United States of America and deprived of iodine in their food become completely hairless. Human beings with deficient thyroids also lose their hair. The results which we have obtained in the south-eastern districts of South Australia indicate very strongly that other deficiences may affect the ability of the thyroids to store or to utilize iodine. This is particularly true of phosphoric acid deficiency, a fact which has hitherto escaped notice elsewhere.

The first series of analyses at a single field station, "Bulu Gherin," in the Western District of Victoria, has been completed, and the results published in the March issue of the *Australian Journal of Experimental Biology and Medical Science*. They indicate that glands collected in the late spring and early summer months (September, October, and November) contain notably less iodine than those which are collected in the preceding six months. There is nothing, however, to indicate iodine deficiency in the western districts of Victoria. It has also been noted that the glands become larger and heavier in spring, indicating greater activity, although the increase in weight is not sufficient to account for the fall in iodine content. These phenomena are important to understand if we regard fully the various seasonal factors affecting wool production in sheep.

* Published in the March (1929) issue of the *Australian Journal of Experimental Biology and Medical Science*.

2. Investigations at the Waite Agricultural Research Institute.

The Calorimeter.—The erection of the calorimeter has been completed, and several trial runs have been carried out. It is proposed to utilize this calorimeter, in the first instance, for the following purposes:—

(i) To determine the basal nutritive requirements of sheep on a normal diet at different ages.

(ii) The requirements of the animal vary to some extent with its previous history, and a ration which is insufficient to maintain condition initially may ultimately become sufficient when the animal is habituated to deprivation. Accordingly we will re-estimate the requirements of the sheep when set on a typical drought recipe, choosing from among those which have been ascertained to be adequate in Queensland.

Our preliminary estimates indicate that a merino sheep in Australia has a lower nutritive requirement than sheep in Europe and America.

Growth Investigations.—Experiments are being carried out in order to ascertain the maximal growth obtainable by merinos, thus giving ourselves a standard, which, even if unobtainable in practice, serves as a guide to what might be expected if practice could be made perfect. Under the experimental conditions, the growth obtained in merinos actually exceeds that obtained with cross-bred fat lambs grown under ideal natural conditions in South Australia for the fat lamb market. The wool of our lambs nevertheless maintains its excellent quality.

"Break" Experiments.—Experiments designed to bring about artificial "break" in wool have succeeded, and we have now learnt how to produce this condition at will. The next thing is to find addenda to the "break" producing diet which will most effectively and cheaply prevent it.

Ewe's Milk.—Several samples of ewe's milk have been analysed. One feature is the high content of lactalbumin, rich in cystine relatively to casein, which is very poor in cystine. In cow's milk and in human milk lactalbumin is not nearly so abundant.

Banded Wool.—A ewe having the rare peculiarity of furnishing black and white wool in bands has been obtained, and we proposed to ascertain by hand feeding what conditions produce the change in the colour of the wool. Much light may be thrown upon the physiology of wool production by such experiments.

Wool Hydrolysate.—Wool is being hydrolysed at minimal acidity under high pressure of steam. Under these conditions it is found that wool may be rendered soluble and digestible without destruction or alteration of the cystine which it contains. This preparation has been administered to sheep with the object of ascertaining whether any effect is produced upon the growth of wool. The experiments to date have so far definitely shown that wool production is increased by such means. This information is encouraging, because it indicates that a suitable concentrate may be found to favorably influence the production of wool.

Influence of Removing Thyroids on Sheep.—With a view of gaining all possible information regarding the relation of the thyroid gland to wool-production, the glands have been removed from four animals. The effects on the growth of their wool will be noted.

3. Field Stations.

(i) *"Kolendo," via Port Augusta, South Australia.*—This station has been temporarily closed on account of the drought, which has not yet broken. Arrangements have been made whereby the field officer will still continue to provide us with thyroids and with other specimens, such as the foliage of bushes used for stock feeding in drought times, which we need from time to time.

(ii) *"Buln Gherin," near Beaufort, Victoria.*—This was our first field station, and has proved an unqualified success. Our field officer has collected 140 thyroid glands for us, of which a large number has already been analysed. This wealth of material from the same source has enabled us for the first time to undertake a statistical study of the distribution of iodine in the thyroids of a population of sheep.

Experiments are also being carried out at this station on the supplementary feeding of yeast to sheep.

(iii) *"Keytah," Moree, New South Wales.*—This station is situated in an area where, in addition to the obtaining of the usual field station data of growth, wool production, &c., a survey of thyroid glands will be valuable. Such a survey is now being carried out.

The owner of "Keytah," Mr. E. D. Ogilvie, also owns a sheep station in New England, and at his request we suggested the composition of a lick to him for use there. He reports that this lick has accomplished excellent results. It is now being adopted by some of his neighbours, and will undoubtedly spread throughout New England within a short time. We are also conducting experiments with the feeding of one or two supplements to determine whether the carrying capacity of New England pastures during the winter can be increased.

(iv) *"Meteor Downs," Springsure, Queensland.*—This field station is on the property of Mr. D. E. Donkin, and was opened in December, 1928. The district is one of the most interesting in Queensland. The growth of vegetation which the soil can produce is extraordinary in amount, and the rainfall (25 inches per annum) is such that drought is very rarely experienced. The station is excellently placed from the point of view of the collection of fundamental data of the nutrition of sheep over large areas of Queensland, and thus under conditions approaching those encountered within the tropics.

In addition to the obtaining of this data, some experiments on the feeding of supplements rich in protein are being carried out. In connexion with the use of these supplements, it should be pointed out that the indirect advantages resulting from their use may far outweigh in importance the direct advantages. Thus, in the Springsure district the difference between the minimum and maximum carrying capacity of the country at different seasons of the year is so great that, since the carrying capacity for the year is determined by the minimum capacity, the country can never be sufficiently stocked to keep the grass down. If the country could be more heavily stocked, the grass would be kept back, and the fresh shoots would be far more nutritious. The first step towards this heavier stocking is to smooth out as much as possible the fluctuations of carrying capacity, and supplementary feeding during the minimal month is a mode of contributing towards this end.

(v) *Future Field Stations.*—Now that we have four field stations in operation, and have proved that the type of organization we have devised is a successful one, I wish to point out the very great advantages attaching to this method of conducting field experiments. At the present moment we have, or are about to have, 1,200 sheep employed in the investigations under our control, without having been put to any expense in the purchase of sheep or lambs. At the same time, these sheep are under supervision of the highest efficiency. I refer, not only to our own field officers, but to the owners, who are taking a lively interest in the experiments, and are watching the sheep they have made available to us even more closely than the remainder of their flock. We could not obtain such skilful overseeing of the animals ourselves, except at very great expense.

While it is not advisable to start too many field stations simultaneously, it is nevertheless quite possible for us to open two or three per annum, always recollecting that after the lapse of two or three years some of the earlier field stations may close down if we think that we have obtained from them a sufficient amount of information. To cover New South Wales adequately, at least four more field stations should be established, and a proposal has been mooted to call together a small committee in New South Wales to divide up the pasture areas in typical districts, suggesting a site for a field station in each of them. At the same time, I will be very glad to have the opportunity to establish in the near future one field station in Western Australia, in the Kimberley district, where the sheep grow exceptionally fine wool, even when the sheep imported for breeding purposes are the strong-woolled type. I would also wish to establish a field station in a district in which phosphoric acid deficiency is of a drastic character.

I think it necessary to reach a decision at this stage as to whether development of this type of work is to be permitted to proceed naturally until, if successful, it has obtained considerable dimensions. It must be remembered that each field station constitutes a focus from which knowledge and suggestions are disseminated. I find that pastoralists are very eagerly watching each other, and are extremely ready to adopt any procedure found successful by a neighbour for whom they have respect. Both as centres of investigation and channels of education these field stations, at which we are the guests of practical pastoralists of high standing in their profession, seem to me of very great value.

An Investigation of Western Australian "Braxy-like Disease" of Sheep.

By H. W. Bennetts, B.V.Sc.

A "braxy-like disease" of sheep has for some years—since 1915—been responsible for considerable economic losses over large areas of the southern portion of the State.

The disease is characterized by sudden fatal termination, usually without premonitory symptoms, and a definite seasonal incidence—April to October. Only fat sheep are affected, though age (three months on), sex, and breed appear to have no influence.

The incidence and distribution, within the now affected area, varies greatly in different years, and in a most baffling manner. The disease is invariably associated with depasturing of sheep on cultivated country—fallow, crops—and losses do not occur on "bush" country.

Prior to the writer's seconding to the Council for Scientific and Industrial Research in April, 1928, he had studied the disease from the field aspects, and had also investigated the pathology and bacteriology of the condition. The affection was found to be toxaemia, and no primary lesion could be detected; neither were any species of bacteria isolated which could be regarded as causal agents. The disease was evidently quite distinct from the braxy-like diseases of Victoria and New South Wales. Liver flukes also are not found in sheep—except introduced—in Western Australia.

It was thought that the local disease was possibly a gastro-intestinal toxaemia.

Since April, 1928, the writer's whole time has been devoted to the investigation of this disease. As a result, strong evidence has been adduced to incriminate *Bacillus welchii* as the probable cause of death. *B. welchii* is an organism known to be very widely distributed in nature, being found in soil and in the intestines of man and animals. In cases of the disease under investigation, *B. welchii* has been found to be present in enormous numbers in the contents of the small intestines of sheep examined immediately after death, whereas in normal sheep examined the organism, though cultivable, has only been present in small numbers.

Further, the germ-free filtrates of the same small intestine contents have been shown to be highly toxic for laboratory animals, such toxicity being proved to be due to the *B. welchii* toxin contained in the filtrates. Control normal sheep have shown no such toxicity of intestinal contents. It has been shown possible to reproduce the disease in sheep artificially by inoculating germ-free filtrates of small intestine contents of an affected sheep, and also by inoculation of *B. welchii* toxin produced in an artificial medium.

The pathological picture in natural cases is quite in accord with a *B. welchii* toxaemia, and the pathological picture of experimental cases is of the same order. The incidence, &c., of the disease would argue in favour of the view put forward.

The present conception of the disease is that certain predisposing factors favour the proved excessive growth and toxin production of *B. welchii* in the small intestines. Death is caused by the absorption of this toxin—absorption being assumed from the effects produced.

It has not yet been possible artificially to reproduce the disease by the mouth—the natural method—in the absence of the knowledge of predisposing factors.

The investigation is proceeding, and this phase of the problem is receiving attention.

Kimberley Horse Disease.

By D. Murnane, B.V.Sc., Veterinary Research Officer, Council for Scientific and Industrial Research.

That *Atalaya hemiglauca* ("whitewood") in North-western Australia is toxic to the horse has been proved conclusively by earlier work.* A later experiment conducted by the writer at the Veterinary Research Institute, Melbourne, established the fact that the plant retains its toxicity even after having been dried for some months.† A further test, the details of which are given below, has now been made:—

Subject No. 14.—Brown Gelding, Aged.

Material used in feeding experiment.—Dried leaves of *Atalaya hemiglauca*, obtained in North-west Australia in November, 1927.

The animal received 2 oz. daily in its ordinary food from 4th September, 1928. On 4th October (one month later) the daily dose was increased to 8 oz. There was no sign of illness. On 14th November, the animal was rather dull, and was observed to yawn frequently, but otherwise he appeared quite healthy. The yawning symptoms continued and, on 1st December, the animal was noticed to be off his food, showed symptoms of mild colic, and went down. When forced to rise, he exhibited a staggering gait, and soon went down again. Periodically he would rise and feed. The limbs were seen to be very rigid, and there was marked oedematous swelling of the supra-orbital fossae. The animal continued in this state during the following day, and on 3rd December, at 9.15 a.m., he died after a slight struggle.

Post-mortem.—The examination was made immediately. There was considerable bruising of the supra-orbital regions, and extensive swelling of the fossae. Marked jaundice of the visible mucous membranes and subcutaneous tissue was seen. Abdomen—There was some excess of peritoneal fluid—500 to 600 c.c. of clear, straw-coloured fluid. Stomach—Empty. There were numerous *Gastrophilus* larvae present. The mucous membrane was congested, and showed a very pronounced

* Commonwealth Council for Scientific and Industrial Research, Australia, Bulletin 36 (1928).
† Ibid. p.48.

catarrhal condition, with areas of desquamation. Intestines—Considerable congestion of the mucous membrane of the colon and caecum. Small intestine practically normal. Kidneys—Both slightly enlarged. and considerably congested. Adrenals—Somewhat congested. Mesenteric lymph glands—Rather congested, but not much enlarged. Bladder—Full, urine a dirty brown or coffee-coloured, much sediment, and many flocculi present. The qualitative biochemical examination of the urine showed the presence of blood, albumen, bile salts, and sugar. Liver—Very much enlarged, 20 lb. in weight, highly congested. Heart—Normal, no endocarditis or pericarditis noted. Lungs—Normal. Mediastinal lymph glands—Normal.

Microscopical Examination of Liver.—The liver presented a picture of a violent hepatitis, together with a very extensive destruction (degeneration) of liver cells. The blood vessels were very much distended. Here and there throughout the parenchyma, irregular haemorrhages (blood lakes) were seen. The liver cells immediately surrounding the central veins showed the most pronounced change, and of the nature of distension and vacuolation. This degenerative change frequently extended outwards from the central vein until at least half of the cells of the lobule were involved. There was a pronounced formation of new interlobular fibrous tissue in an early (fibroblastic) stage, and numerous areas of haemorrhage beneath the capsule could be seen.

Conclusions.

1. Continued or repeated ingestion of *Atalaya hemiglauca* of North-western Australia has a delayed but fatally toxic action on the horse.

2. The toxic action of the plant has been retained for at least twelve months after drying.

A Note on the Diagrammatic Representation of the Mechanical Analysis of Soil.

By Professor J. A. Prescott, Professor of Agricultural Chemistry, Waite Agricultural Research Institute, University of Adelaide.

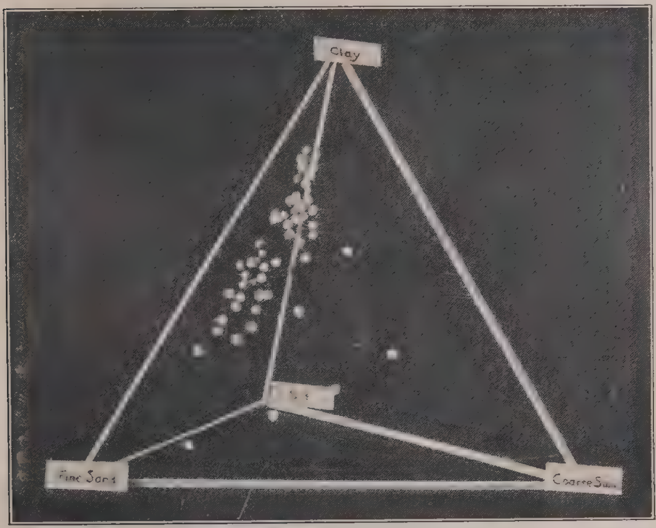
The representation of the mechanical analysis by means of a point in a triangular diagram is one of the standard methods of presentation, numerous examples of which are given by Whittle (C. L. Whittles, *Journal of Agricultural Science*, 12.166 (1922)). The major difficulty involved has been the reduction of the number of soil fractions to three arbitrary groups representing fine, coarse, and medium soil particles, the actual limits varying with the standards recognized in each country, and by each individual worker. The reduction of the number of fractions to four by international agreement, and the adoption of these units by British workers, makes it possible to represent the mechanical analysis of any soil expressed in these units by means of a point in a tetrahedron, each apex of which represents 100 per cent. clay, silt, fine sand, or coarse sand.

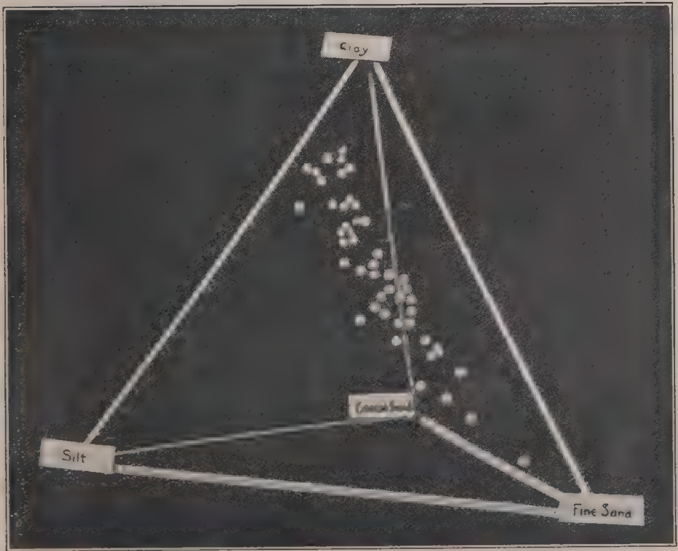
When a series of soils is plotted in this way, a remarkable arbitrary relationship appears to exist, the mechanical analysis of any given soil series would appear to fall about a plane. Where the two sand fractions are grouped in order to obtain the three major divisions, for use in the triangular diagram, the mechanical analyses group themselves about a straight line, illustrations of which will be found in the paper by Bainbridge [E. P. Bainbridge, this *Journal*, **1**, 341 (1928)] on the Australian tobacco soils, and in the work of Taylor and England (J. K. Taylor, and H. N. England, C.S.I.R. Bulletin in preparation) on the soils of Renmark. Other such series which have been worked out in a similar way are the soils of Mount Gambier (South Australia), the Mallee soils of South Australia and Victoria, and the Nile alluvium. The tetrahedral representation illustrated in Plate 1 takes the soils of the Nile alluvium as an example. A series of analyses from the writer's records have been interpolated to the new British standards with oven-dried fractions. The grouping of the mechanical analyses about a plane within the tetrahedron determined approximately by the intercepts – clay 75, silt, 25; fine sand, 100; coarse sand 95, silt 5—is to be noted.

There is a further possibility that this method of presentation will prove very useful in the presentation of soil survey data, and in the correlations between "single unit" values for the physical properties of the soil and the mechanical analyses.

PLATE 1.

THE DIAGRAMMATIC REPRESENTATION OF THE MECHANICAL ANALYSIS OF SOIL.





Photographs from two view-points of a tetrahedral representation of the mechanical analyses of a series of soils from the Nile alluvium.

PLATE 2

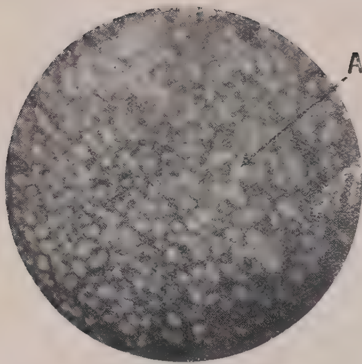


FIG. 1.
Schnapper: Brine frozen, cross section (x 70).

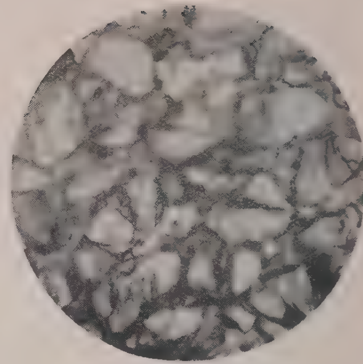


FIG. 2.
Schnapper: Air frozen, cross section (x 70).

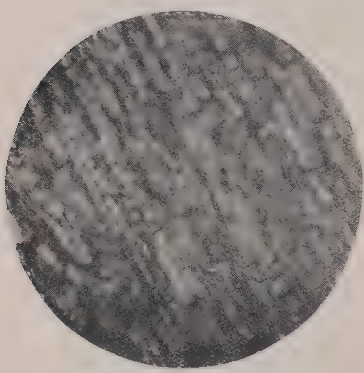


FIG. 3.
Schnapper: Brine frozen, longitudinal section (x 70).

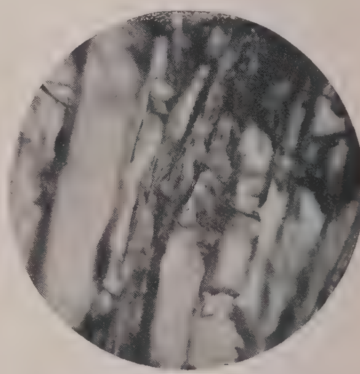


FIG. 4.
Schnapper: Air frozen, longitudinal section (x 62).

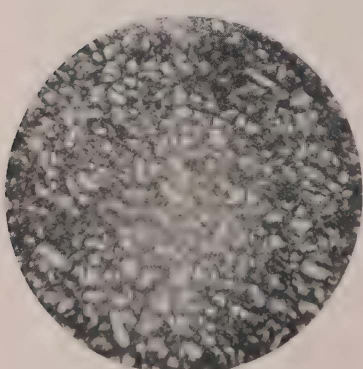


FIG. 5.
Flathead: Brine frozen, cross section (x 62).

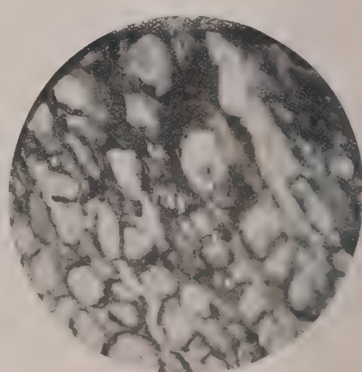


FIG. 6.
Flathead: Air frozen, cross section (x 62).

PLATE 3.

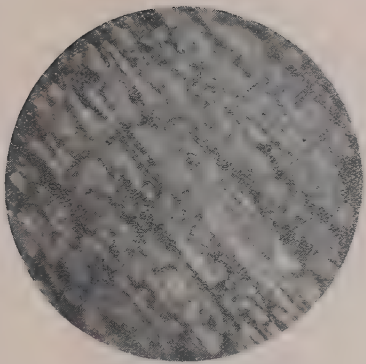


Fig. 7.
Flathead: Brine frozen, longitudinal section (x 70).

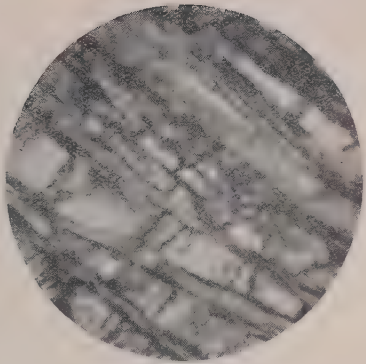


Fig. 8.
Flathead: Air frozen, longitudinal section (x 70).

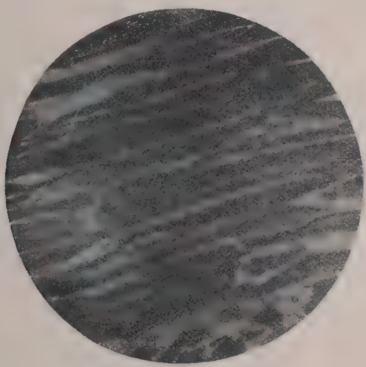


Fig. 11.
Flathead: Normal fresh muscle, longitudinal section (x 70).

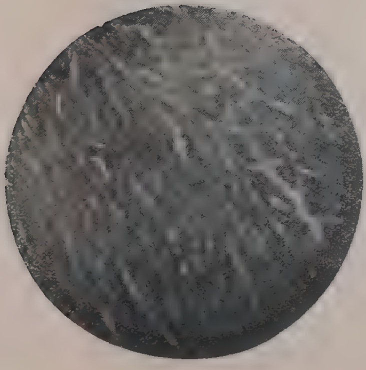
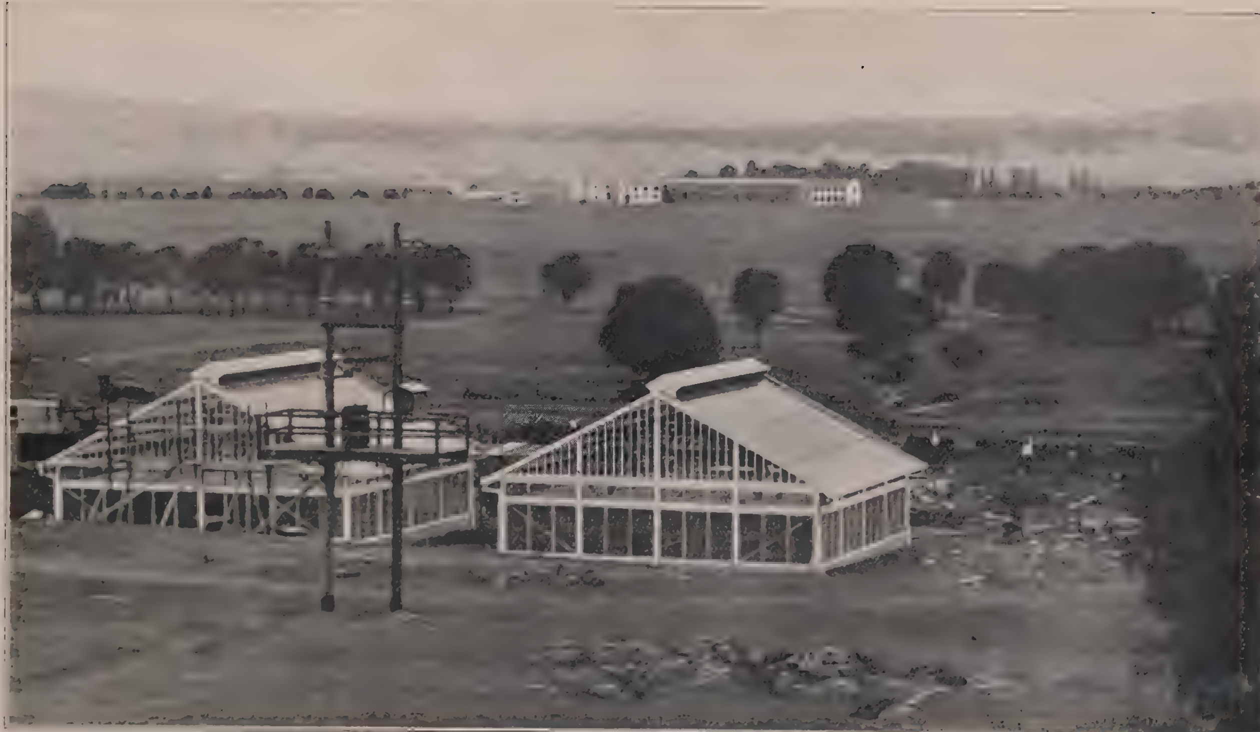


Fig. 9.
Flathead: Brine frozen, longitudinal section (x 70).

Fig. 10.
Flathead: Air frozen, longitudinal section (x 62).

PLATE 4.



LABORATORIES AT CANBERRA FOR THE COUNCIL'S DIVISION OF ECONOMIC ENTOMOLOGY.

In the foreground can be seen two Insectaries, and just behind these the brickwork of the Laboratories in course of erection. The large group of buildings in the centre background constitute the Civic Centre. To the left of them is one of the residential areas of Canberra (Ainslie). This photograph was taken on the 25th March, 1929.

NOTES.

Sir George Julius, Kt.

The Chairman of the Council, Sir George Julius, has recently had the honour of knighthood conferred upon him. For many years, Sir George has devoted a very considerable proportion of his time to public service. His position as Chairman of the Council—an organization that is rapidly growing, and fitting itself to take a place as one of the instruments available for the solving of at least some of the complicated national problems affecting Australia—has involved him in duties that are never-ending, and by no means light. In addition, he has been Chairman of the Australian Commonwealth Engineering Standards Association for years, and has recently agreed to act as Chairman of the combined body, consisting of that Association and the more recently formed Association of Simplified Practice. The far-reaching activities of the Standards Association, and the value of its work, are well known. It may suffice to say that there are now few technical men in Australia who have not, at some time or other, been connected with its various committees. Sir George has also been a member of the Council of the Institute of Engineers, Australia, since the Institute's inception, and was its President in the year 1925.

Appointment to Council of W. J. Young, Esq., C.B.E.

The Governor-General has recently approved of the appointment of W. J. Young, Esq., C.B.E., to the position of Chairman of the South Australian State Committee of the Council, *vice* Professor T. Brailsford Robertson (resigned).

Mr. Young, who is managing director of Messrs. Elder Smith and Co., Adelaide, and thus has an intimate knowledge of the Australian pastoral industry, was present at one of the meetings of the full Council in March last. In addition to being associated with Messrs. Elder Smith and Co., Mr. Young has been connected with the Commonwealth Central Wool Committee since its creation in 1916, and is at present Vice-Chairman of that body. He is also a member of the Council of the University of Adelaide, and the Chairman of its Finance Committee.

During the war he was a member of the Commonwealth Shipping Board, and in 1923 was a member of the Advisory Committee to the Prime Minister at the Imperial Economic Conference. He was recently commissioned by the Government of South Australia to act as Chairman of a Committee appointed to advise on the financial position of South Australia.

The British Economic Mission.

Several interesting references to the Council for Scientific and Industrial Research and its work are made in the Report of the British Economic Mission, which was published last January. The opinion is expressed that the Council is capable of being a nucleus for the combination and co-ordination of the scientific and technical knowledge already available in many quarters in the different States, and a potent force for the increase of the sum of that knowledge through the work of its scientific Divisions.

The report goes on to state that the possible opportunities for the results of scientific study in many fields, such as those of agriculture and dairying, with a view to the increase of productivity and the diminution of costs, are incapable of measurement. The Mission considered that the more intensive use of the already partially developed resources of Australia was among Australia's principal needs to-day, and that a great deal in that direction could be achieved by the Council and the Development and Migration Commission working in close co-operation, not only with each other, but also with all the other institutions in the Commonwealth with which they have connexions. In that way, rather than from scientific schemes for new extensive development, it was believed that a natural stream of migration from Great Britain to Australia would flow, having its source in the increasing productivity and consequent absorptive power of the Dominion.

So much importance did the members of the Mission attach to this idea of more intensive development of areas already settled, that they suggested that the scope of the £34,000,000 agreement should be enlarged so as to permit of the funds made available under it being used in other ways, and particularly for the purposes of assisting the work of scientific research through subsidies to appropriate institutions, and of facilitating large scale experiments and the like, without attaching to the expenditure of moneys for these purposes the condition that any specific proportionate number of immigrants must be received in Australia.

In a supplementary memorandum to the report dealing specifically with the Council and the Development and Migration Commission, the members of the Mission emphasized their appreciation of the services the two bodies are rendering to Australia, not only by their direct investigations, but by fostering a spirit of co-ordination and collaboration between the various Commonwealth and State Governmental agencies. The Mission was satisfied that the results which both the Council and the Commission had achieved were eminently satisfactory, especially in view of the short time they had been in existence, and it considered that their hands should be strengthened in every practical way, especially by the appointment of further trained staff, as necessary.

Whilst the Mission appreciated that the relationship between the Council and the Development and Migration Commission is a cordial one, it thought that closer co-operation was desirable, and that the work of the Economic Research Bureau, the creation of which was advocated in the report, should be brought into co-ordination with the activities of the Council and the Commission. The view was also expressed that

it would be greatly to the advantage of the commercial and manufacturing prosperity of Australia if there were added to the present activities of the Council for Scientific and Industrial Research the sphere of work which deals with standardization and simplification of manufacturing processes.

Effect has already been given by the Commonwealth Government to the latter recommendations. A Co-ordination Committee, under the chairmanship of Senator the Rt. Hon. Sir George F. Pearce, P.C., K.C.V.O., and consisting of representatives of the Council, the Development and Migration Commission, and the Department of Markets and Transport, has been appointed, and has already held its first meeting. The Government has also arranged that the Council shall act as the means of liaison between the Government and the Engineering Standards Association and the Association for Simplified Practice.

Experiments on Banana Ripening.

Progress has been made with the experiments on the maturation, storage, and transport of bananas mentioned in a previous issue of this *Journal* (Vol 1, No. 6, p. 371). The ripening rooms have been completed at the Universities of Melbourne and Queensland, and active investigations were commenced some time ago.

It is intended, in the first instance, to carry out experiments with a view of obtaining further information on the following matters:—

(*a*) The best average conditions for the proper ripening of the Cavendish banana.

(*b*) The difference, if any, between bananas ripened on the bunch or in the case.

(*c*) The effect of ripening in the case when packed singly, in small hands or in full hands.

(*d*) The effect of pre-ripening of bananas exposed to exceptionally cool conditions during transport.

(*e*) The development of black ends.

(*f*) The effect of adverse transport conditions on subsequent ripening.

(*g*) The effect of leaf spot on the ripening of fruit from affected plants.

(*h*) The "squirter" condition in bananas.

In addition, the State Railway Departments of Queensland, New South Wales, and Victoria, have decided to co-operate, and have arranged for the installation of temperature control apparatus on railway wagons carrying bananas. By the use of this apparatus, it is hoped to determine the best conditions under which to transport bananas.

The results obtained in the first few experiments carried out in Queensland, which were commenced at a somewhat earlier date than those in Melbourne, have been encouraging. In the first set of experiments, bananas of a low grade were ripened at varying temperatures. Even fruit of poor quality ripened with very satisfactory flavour, aroma, and colour, and after ripening was kept under trying conditions of temperature and humidity for several days without undue deterioration taking place. In the second set of experiments, good-quality fruit

was used, and this ripened up and kept very satisfactorily. The experiments at Melbourne have as yet been confined to the ripening of cased bananas in singles or in small hands.

Investigations on Noogoora Burr.

Arrangements have recently been made for some work on Noogoora burr to be undertaken in two different directions. As indicated in a previous issue (Vol. 1, No. 6, p. 374), this pest is spreading at a somewhat alarming rate, more particularly in Queensland.

Late in February last, Dr. Jean White-Haney, of the headquarters staff of the Council, was seconded to the Division of Economic Botany, in order that she might investigate the problem. She is now in Queensland, and, during the next few months, will gather information regarding the life-history of the plant, its rate of spread and present distribution, its economic importance, &c.; and she will also investigate the possibilities of control. Previously, Dr. White-Haney was for many years very closely associated with the investigation of the prickly pear problem in Queensland.

Another avenue that will be explored to a certain extent is the entomological. Whilst in the United States last year, Dr. Tillyard discussed with Professor G. A. Dean, State College, Manhattan, Kansas, the question of arrangements being made by the latter to carry out for the Council investigations on insect enemies which attack species of *Xanthium* (Noogoora burr is probably *Xanthium strumarium*). As a result of recent cable communications, Professor Dean has arranged for one of his post-graduate students to carry out this work during the forthcoming summer months.

Research in Economics.

A decision has now been made regarding the organization of the research in economics which the Commonwealth Government has decided to carry out in Australia. The main reasons prompting the Government to have some such research work initiated are outlined in the previous issue (Vol. 2, No. 1, p. 58 of this *Journal*).

At one time, it was thought that the investigations could appropriately be undertaken by a special "Economics" Division of the Council. The British Economic Mission, which recently visited Australia, concerned itself with the matter, and its comments are as follows:—

> "It has been proposed to establish a service to deal with economic problems, and that this service should form part of the work of the Council for Scientific and Industrial Research; but the sphere of activities of the proposed service is, in our opinion, so important as to demand a separate organization. Moreover, we think that such an arrangement would be desirable in order that the present work of the Council for Scientific and Industrial Research should not be prejudiced in any way by the action or conclusions of the new service. This new service must necessarily deal with problems which directly affect the political life of the country, and it must accordingly be placed and regarded as entirely outside the sphere of political influence, and its recommendations considered as scientific and unbiased."

The Commonwealth Government has now decided to set up an independent Economics Bureau to carry out the investigations, and has passed an Act for that purpose.

British Department of Scientific and Industrial Research: Annual Report.

The 13th Annual Report (for the year ended 31st July, 1928) of the above Department has just become available in Australia. It would be quite impossible in a short abstract to cover the numerous activities of the Department, and the paragraphs that follow have therefore been confined to mention of new activities or to matters of special interest.

A new Chemistry Research Board has been set up by the Department, with the duty, *inter alia,* of supervising generally the researches undertaken at the Chemical Research Laboratory recently erected in the grounds of the National Physical Laboratory, Teddington. In addition, a Metallurgical Research Board has been created. One of the functions of this Board is to review periodically the large volume of metallurgical research in progress, more particularly that carried out by Government bodies, and to make arrangements for the interchange of information and for co-operation with industry.

During the year under review, the high voltage plant at the National Physical Laboratory, designed to enable measurements to be made on insulators up to a pressure of 1,000,000 volts, was completed. As a result of the Department's general researches, some eighteen applications for British patents have been made. An investigation by the Radio Research Board of the application to marine navigation of the type of rotating radio beacon developed by the Air Ministry as an aid to aerial navigation has been completed, and as a result a more permanent beacon is being erected on the east coast, where it will be available for practical use by shipping. Mention is made of the fact that, with the object of securing the utmost efficiency in the British seaplanes, which made so successful an entry in the contest for the Schneider cup last year, a number of investigations extending over about two years were carried out for the Air Ministry in the wind tunnels at the National Physical Laboratory.

From a perusal of the report, it is evident that some interesting work is in progress at the Building Research Station in regard to cement and concrete, and particularly in connexion with quick-setting cements less costly than the aluminous variety. Various new ideas in structural design are also being studied.

The Minor Metals Research Committee has paid much attention to the possible uses of beryllium which, while having considerable strength, a high melting temperature, and a low co-efficient of thermal expansion, is a much lighter metal than aluminium, and is not easily corroded when exposed to ordinary air. Provided it be proved to be available in sufficient quantities, it will find a large number of practical uses.

The Advisory Council of the Department draws attention to the large development of industrial research that has taken place in Great Britain during the year under review, and states, further, that the rapid development of scientific investigation in the chemical industry has caused the Department some embarrassment through the resignation

of many of its staff to take up research posts elsewhere. In commenting on this position, the Advisory Council states: "While the loss of experienced men is bound to delay to some extent the progress of investigations of general national importance, there is the compensating advantage that, at a time when the expansion of work of more immediate industrial interest is highly desirable, it is extremely helpful to industry to be able to turn to national organizations for the supply of men who appreciate some at least of the difficulties of getting practical results."

For the financial year ending on the 31st of March, 1928, the expenditure of the Department, which practically confines its attention to problems of the secondary industries as distinct from the agricultural, was £506,000.

Radio Research: New Proposals.

For some time past, the Radio Research Board of the Council has been co-operating with the Universities of Sydney and Melbourne in work on the variation and distribution of field strengths of transmission of broadcasting stations in their respective localities. It is now proposed to extend the work of the Board to other problems.

The full programme of the Board is as follows:—

A.—University of Melbourne.

(*a*) *Field Intensity Measurements.*—Measurements of the field of 3LO (and partly of 3AR) up to distances of 20 to 30 miles (in one case to 80 miles) have been made. It is proposed to extend these in certain directions to 75 miles. The silent area at Yallourn, the hill effect, and certain other anomalous effects which have been noted, will be further investigated.

(*b*) *Measurement of Modulation.*—This problem will be investigated to determine the best methods of making practical measurements.

(*c*) *Fading and Distortion.*—It is considered desirable that a qualitative study of fading and distortion, to be followed by investigations on the line of Appleton and his co-workers, should be undertaken.

(*d*) *Atmospherics.*—A study of—

- (i) the region of origin of atmospherics affecting south-eastern Australia;
- (ii) the variation of their number and intensity, both diurnally and seasonally;
- (iii) their predominant characteristics

will be made.

B.—University of Sydney.

(*a*) *Field Intensity Measurements.*—The work of field intensity measurements in the neighbourhood of Sydney dealing particularly with radiation from the present A class stations and from Garden Island will be continued. An investigation of the absorption effects of the Blue Mountain Range and further investigation of the marked directive effects which have been indicated from previous observations will also be carried out.

(*b*) *Fading and Distortion.*—A qualitative study of the effects of fading and distortion experienced from the signals sent from the neighbourhood of Sydney, particularly in relation to Newcastle. will be made. Preliminary work to determine suitable sites for carrying out a repetition of Appleton's experiments in regard to the height of the Heaviside layer, and the important question of the rotation of the polarization of the reflected rays, will be continued.

(*c*) *Atmospherics.*—A study of—

(i) the regions of origin of atmospherics affecting New South Wales and the Federal Capital Territory;

(ii) the variation of their number and intensity, both diurnally and seasonally; and

(iii) their predominant characteristics

will be made.

The primary object of the above investigations is to collect information likely to be of considerable value to the development of the broadcasting and other radio services of the Commonwealth. The new work will be carried out in co-operation with the Universities just named, and will be financed almost entirely by equal contributions from the Postmaster-General's Department and the Council. It is realized, however, that some delay may be experienced in obtaining the services of the necessary personnel. Applications are now being invited for appointment to four new positions that have been created.

The Buffalo-Fly Pest.

In previous issues (Vol. 1, pp. 55, 289), accounts have been given of the buffalo-fly (*Lyperosia* sp.) problem in Australia, and of investigations aimed at obtaining information for its control. Some further progress in the organization of the work has now been made, although it was delayed by the lack of the necessary entomological personnel.

Arrangements have been made for Dr. Ian Mackerras, a Senior Entomologist of the Division of Economic Entomology, to sail for Java on the 20th of April. He will spend about four weeks in Java, and about a fortnight in Timor, making himself acquainted with the work already done for the Council by Dr. Nieschulz, and making further inquiries regarding possible parasites of the buffalo fly. He will then proceed to Darwin, and if his work justifies it, will establish a station there for the breeding of promising parasites. Later, he will most likely go to Wyndham, and afterwards to Perth, in order to discuss matters with the local Department of Agriculture.

Another member of the entomological staff of the Council, Mr. T. G. Campbell, sailed in the *Malabar* on the 7th of March, for Darwin. He will study certain aspects of the life-history of the fly, such as—

(i) The range of flight of the fly.

(ii) Can the fly breed in dung of native animals or sheep?

(iii) Can native animals aid the spread of the fly?

(iv) The present geographical range of the fly, especially the southern limit.

(v) Are there any local parasites or predators?

(vi) The best conditions of pupation in different soil areas.
(vii) The possible use of traps as controls; and
(viii) Any other observations or details of the life-history.

The information thus obtained will obviously be very helpful in deciding upon the probable effectiveness of the buffer area that has been suggested be established along the Queensland western border with a view of preventing the further spread of the fly eastward.

After the completion of these investigations, Mr. Campbell will travel with a mob of cattle to Camooweal in order to ascertain whether at any particular point the flies leave the beasts. If they do, he will then make a close study of all climatic conditions at that place. He will return to the Territory later, and probably travel towards Wyndham, but at this stage his plans cannot be determined definitely.

In addition to the operations already referred to, action is being taken to secure the services of two junior entomologists, who will act as understudies to Dr. Mackerras, and who will assist him. One such junior entomologist—Mr. G. L. Windred—has already been appointed. He left for Java with Dr. Mackerras in April last, and the present arrangements are that he will stay in that country for some time in order to continue the search for likely parasites.

Meetings of the Full Council.

The meetings comprising the seventh session of the full Council (for Scientific and Industrial Research) were held in Melbourne on the 25th, 26th, and 27th of March, 1929. Some of the more important matters discussed, and not mentioned elsewhere, were as follows:—

Imperial Agricultural Research Conference—Australia, 1932.—As a result of the discussions the Secretary (Mr. Lightfoot) had during his recent visit abroad with various officers of the British Ministry of Agriculture, and with Mr. F. L. McDougall, it has become apparent that the present is none too early to commence the preliminary organization of this Conference. The Council considered lines of procedure suggested by Mr. Lightfoot. It has now been decided to discuss the Conference, and the arrangements that should be made in regard to it, at the next meeting of the Standing Committee on Agriculture, which is to be held in about June next. It was generally felt by the individual members of the Council that the time available to the visiting members would be much too short to allow of any attempt being made to move the Conference as a whole to every State of the Commonwealth, and for that reason, that it might be necessary to split the members into various parties so that every State would receive some of them at least. It was also considered that the possibilities of having technical papers read at the Conference should be borne in mind.

Animal Diseases.—The arrangements made for Sir Arnold Theiler to be offered the position of Consultant to the proposed Division of Animal Health were confirmed. It is expected that Sir Arnold will reach Australia some time in July next, and that he will spend the subsequent twelve months here. In the meantime, it has been decided that immediate attention will be given to further work on caseous lymphadenitis without waiting for his arrival.

Forest Products Research—Report of Mr. I. H. Boas (Chief of the Division).—A considerable amount of attention was given to a report furnished by Mr. Boas on the observations made during his tour abroad and his ideas as to forest products research in Australia. The recommendations were to the effect—

(i) that the programme of work of the Division be initially confined to seasoning, preservation, chemical investigations, and wood technology; and

(ii) that as opportunity offers, the programme should be extended to the testing of timbers for their physical properties, a survey of the variation in specific gravity of the hardwoods within the species, industrial investigations covering all classes of timber-using industries, and pulp and paper studies.

Mr. Boas also indicated that an amount of attention would also need to be given to entomological and mycological matters as they affected forest products.

The programme has been endorsed in general, and further consideration is now being given to the details.

The Storage, Preservation, and Transport of Food.—Mr. Lightfoot submitted a summarized statement regarding the inquiries he had made on this subject in England, particularly from the point of view of the co-ordination of any Australian work with that of the British Food Investigation Board. As regards fruit, he pointed out that much information of value could be obtained by the continuation of the practice of sending experimental shipments to England, also that further work was needed in Australia on factors favouring the development of such diseases as bitter pit, internal breakdown, over-ripeness, and fungal rotting. By arrangement with Sir William Hardy, Dr. Barker, of the Food Investigation Board, had prepared a confidential report setting out the position and indicating the investigations on fruit that could be usefully undertaken by the Council.

As regards meat, Sir William Hardy had stated that he proposed to carry out a survey of transport conditions of both meat and fruit in the various parts of the Empire, and that the Council could render material assistance in that connexion. The authorities of the British Board considered that further work on rapid freezing of beef was hardly likely to lead to useful results, but they approved of the suggestion discussed by the Australian Meat Freezing Committee that prime young Australian bullocks should be slaughtered and sent to Smithfield, in order to clear up the point as to whether the low prices realized for Australian frozen meat was, or was not, due to the old and unsuitable beef that was slaughtered for export.

The Council is in communication with Sir William Hardy regarding plans for the development of cold storage investigations in Australia in such a way as to ensure the closest collaboration with the work of the British Food Investigation Board.

The Council for Scientific Research in French Indo-China.

With an area of some 310,000 square miles, and a population of about 18,000,000, including 25,000 or more whites, and an increasing production in agriculture and mining, the Colony of Cochin China

is of no little importance to France. Some information has recently been received in Australia concerning the establishment in the Colony of the "Conseil de Recherches Scientifiques de l'Indochine Francaise."

Created by a decree of the Governor-General of the Colony, the Council came into existence in March, 1928. The objects for which it was created, as stated in this decree, are—

(1) To collect and examine the results of scientific researches, both pure and applied, which have been carried out in the Colony, either by scientific institutions, departmental officials, or private individuals; to draw the attention of persons interested to the possible practical application of these results; to co-ordinate these results; and, where necessary, to suggest further researches.

(2) To represent French Indo-China in all matters of scientific importance, either French or international.

The Council consists of some 40 members. Some of them are appointed by virtue of their positions as heads of the various Government Departments, such as the Departments of Health, of Agriculture, of Public Instruction, and of Mines; others are chosen by the public administrators of Indo-China interested in scientific research, and are chosen from the staffs of scientific institutions and research departments; while nearly half of the whole number are chosen for their ability in their own special line of work. By this method of selection, it is hoped to avoid the criticism that the Council is in the hands of officialdom.

There is also on the Council an official representative of the Government, who has not the same power as an ordinary member, but who acts as a liaison between the Council and the Government. A President, Vice-President, and Secretary are elected from among the members of the Council, and with five other members form an Executive Committee, known as the "Section Permanente."

The Council is under the patronage of the Institute of France, the French Academy of Science, and the French Colonial Academy of Science.

Empire Marketing Board Reports—Sisal Hemp, Viticultural Research, &c.

Several interesting additions to the series of publications issued by the Empire Marketing Board have recently become available in Australia:—

(*a*) *E.M.B. No.* 10—*Empire Grown Sisal* is a memorandum issued by the Board, but prepared by the Imperial Institute in co-operation with its special Advisory Committee on Vegetable Fibres. It gives a comprehensive survey of the production and growing importance of the sisal industry in the British Empire. At one time the chief and almost the only fibre employed for rope cordage was true hemp, which is derived from the stalks of *Cannabis sativa*. Subsequently this material was replaced by Manila hemp, which in turn has recently found a competitor in sisal, and to a smaller extent in New Zealand hemp (made from *Phormium tenax*).

Sisal is a hard fibre of great commercial importance, which is produced from the leaves of the plant *Agave sisalana.* This was originally a native of Central America, but has now been introduced into most tropical countries. The Imperial Institute points out that sisal fibre is white and lustrous, possesses good strength and flexibility, and is well adapted for all purposes for which cordage fibres are required. Moreover, the investigation has established the fact that the prejudice against sisal as a marine cordage is based on a misapprehension, as it is very well able to withstand deterioration in sea water. The publication ends by advising manufacturers to turn their attention to sisal grown in East Africa, which it is claimed they will find superior in many respects to other fibres.*

(b) E.M.B. No. 11—*"Viticultural Research" by D. Akenhead, M.A., B.Sc.,* includes information on the cultivation of the vine for table grapes and raisins, as well as for wine making, and is a companion publication to the report on the chemistry of wine making (E.M.B. No. 7). In 1927, the author made a tour of the principal wine-producing areas in Europe. He gives an account of the methods of cultivation including grafting, pruning, and manuring in operation in these countries. Considerable attention has been paid to diseases and pests, and also to physiological disturbances. The author concludes this section by stating that the possibility at some future date of breeding immune varieties which will yield adequate crops of good quality, and of conferring immunity by means of serum injections, is no longer negligible.

The section on table grapes and raisins gives an account of the most successful varieties, the best methods of culture, and the present position in regard to production and marketing.

(c) E.M.B. No. 12—*Report on Insect Infestation of Dried Fruit.*—This publication constitutes Dr. J. G. Myers's account of his visit to Australia during the season 1926-27. Owing to pressure of other work, Dr. Myers has been unable to continue the investigation, but, at the request of the Imperial Bureau of Entomology, the Entomology Department of the Imperial College of Science and Technology has agreed to take over the studies. The results of the work already done by the Imperial College are confirmatory of Dr. Myers's findings, namely, that the infestation of Australian and other dried fruits sometimes occurs in the London docks, &c.

(d) E.M.B. No. 14—*"Grapefruit Culture in the British West Indies and British Honduras"* is a report by Professor H. Clark Powell, Professor of Horticulture, Transvaal University College, Pretoria, on the methods of cultivation of grapefruit and on the possibilities of growing it in the West Indies. At the instance of the Empire Marketing Board, Professor Powell recently visited the principal fruit exporting countries of the Colonial Empire to advise, *inter alia,* as to their methods of cultivation and marketing. His report on grapefruit constitutes but one of several reports he has prepared.

* There is another aspect of particular interest to Australia which is not mentioned in the publication, and that is the possibilities of the production of power alcohol from the waste material of the sisal industry. A considerable amount of attention has recently been given to this matter by French interests, from which it appears that the possibilities of commercial success of a combined industry producing fibre and power alcohol as the main products are distinctly promising.—Ed.

Incidentally, he points out that the grapefruit is a comparatively new article of commerce, but that the demand for it is rapidly increasing, and a market for increasing quantities seems assured.

(*e*) *E.M.B. No.* 14.—*The Survey Method of Research in Farm Economics* is a memorandum prepared by J. P. Maxtin, M.A., B.Sc., of the Agricultural Economics Research Institute, Oxford.

Mineragraphic Investigations: Dr. F. L. Stillwell.

Dr. F. L. Stillwell, who, in August, 1927, was loaned to the Western Australian Government by the Council for Scientific and Industrial Research, through the Development and Migration Commission, for the purposes of a geological survey of Kalgoorlie, has completed the programme of work in Western Australia and returned to Melbourne. A detailed report for publication is now in the hands of the printer for publication as a bulletin of the Western Australian Geological Survey. It is accompanied by a surface geological plan of the Boulder Belt, and by a series of nine composite underground plans at vertical intervals of 400 feet, with four cross sections.

Dr. Stillwell is again associated with the Council for Scientific and Industrial Research, and is pursuing his mineragraphic investigations, which were inaugurated with the co-operation of the Australian Institute of Mining and Metallurgy in January, 1927. The present field of work comprises the unusual telluride minerals which occur in unique abundance in the auriferous lodes of Kalgoorlie. The opportunity was taken, during the recent geological survey of Kalgoorlie, to obtain material for this examination by making a collection of these minerals with the co-operation of the more important mines. A considerable amount of chemical and mineralogical investigation of these tellurides has previously been carried out by Dr. E. S. Simpson, of the Western Australian Mines Department, and others associated with the gold-mining industry, but it is thought that the direct microscopic observations of mineral aggregates and associations, which is possible by mineragraphic methods, might lead to further interesting results.

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